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USSR: Computers

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SCIENCE & TECHNOLOGY

USSR: COMPUTERS

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Computers: Steps to the World Level

18630007 Moscow SOTSIALISTICHESKAYA INDUSTRIYA in Russian No 178, 4 Aug 87 p 2

[Article by V. Kovalenko under the "Roundtable on Socialist Industry" rubric: Computers: Attaining World Standards;" first paragraph SOTSIALISTICHESKAYA INDUSTRIYA introduction]

[Text] How can the lag in the domestic computer technology behind the world level be overcome? This question, that was raised at a roundtable session at the editorial office, brought together the following individuals: V. Kolesnikov and P. Pleshakov, both of whom are ministers; Ye. Velikhov, vice-president of the USSR Academy of Sciences; I. Bukreyev, first deputy chairman of the State Committee on Computer Technology and Informatics; G. Ryabov, chief designer of supercomputers; B. Yermolayev, deputy chief designer of the YeS series of computers; V. Kurochkin, first deputy minister of the radio industry; V. Filanovskiy, first deputy minister of the petroleum industry; V. Bezrukov, director of the USSR Gosplan computer center; S. Bushev, director of the USSR Central Statistical Administration [TsSU] computer center; and other scholars, economists and specialists. The conversation revealed the position of all parties, the principal barriers to progress and ways of struggling with them.

What the Coming Day Holds In Store for Us

The conversation actually began yesterday; to be more precise, with a letter from V. Buksanov, director of the Main Information and Computer Center [GIVTs] of the Ministry of the Petroleum Refining and Petrochemical Industry, who asked that a roundtable examine what seemed to use to be a completely reasonable question: Whay has the firm Robotron, which manufactures the Unified Series (YeS) computers, been able to guarantee a mean time to failure of its computers of 500 hours of operation for several years now, whereas our enterprises produce the very same YeS computers from the very same component base, but with second-rate reliability that can only be obtained after they have been in use for 2 years at that!

"Our colleagues in the GDR have not undertaken anything supernatural," said I. Bukreyev, getting to the essence of the question. "It is simply that they make full use of the capabilities of thermal and electrical tests and other types of conditioning--they shut a computer down and run it until all of the

bugs which turned up in it are burned out. As long as our plants lack such conditioning or only have it in abridged form, the "burning-in" process will essentially be transferred to the user, who will have to endure torment for 1 1/2 or 2 years until his or her computer is broken in and reaches its rated reliability level. The situation is now already changing radically, however. And next year, or at least by the end of next year, we will be able to increase the reliability of computers by one to one and a half orders of magnitude."

"I want to reassure users," said V. Kurochkin, speaking for his enterprises. "By 1 January our plants will also guarantee a mean time to failure (MTTF) of 500 hours."

"In the past 1 1/2 to 2 years we have moved forward at a healthy pace and have already increased the MTTF from 150 to 300 hours," added B. Yermolayev.

You agree that the possibility of obtaining production that is 10- to 15-fold more reliable than it is at present and to do so next year rather than at some distant time in the future cannot help but be a source of joy. This is especially true because we already have computers functioning with triple reliability. Or at least with double reliability, as P. Yermolayev cautiously corrected his Deputy Minister. But the users heard this and shook their heads in doubt. This is probably exactly how our readers would react if no one explained how this promise is being backed up.

The consumer doubt has deep roots. In essence, they have existed as long as computer technology has. All of these years the manufacturer has lived above the criticism of the consumer. He has maintained his aloofness through the protection of the shortages, the higher professional level of specialist-manufacturers, and the muddled accountability system. Under such conditions it was not difficult to prove the illiteracy of a customer who, for example, intended to force a computer configuration into the swampy dampness of the basements of St. Isaac's Cathedral (this anecdote was recounted with relish at our roundtable). Nor was it difficult to prove the backwardness of those who supply the component base, or to introduce similar arguments. These endless arguments wasted time and obscured the true causes, and departmental interests triumphed instead.

And the problem of reliability is not an exception. From a technical standpoint, there were no complications such that, let us say, the complex of techniques used at Robotron could not have been adopted long ago. But from the standpoint of the manufacturer's interest this is a direct loss.

[Boxed item: FACT: Increasing the MTTF of YeS-1061 computers from 150 to 300 hours and that of YeS-1036 computers from 250-300 hours required 550 square meters of additional space, approximately 400 units of equipment (at a cost of more than 2 million rubles), and 170 pairs of worker hands. The manufacturing cycle for computers was lengthened by 16 percent.]

For the manufacturer these are completely nonproductive expenditures. In addition, they reduce production volumes. Here lies the principal reason why

the Robotron technology has not been pushed at our plants. But now the enterprises have started to introduce it. What has changed?

The times have changed. It has become more difficult to pass off departmental interests for state interests. Restructuring demanded truth and orientation toward the end result. This was expressed concretely in the appearance of two authoritative consumer advocates--the State Committee for Computer Technology and Informatics and the State Acceptance Board [Gospriyemka]. They did compel the enterprises to make additional expenditures that should be returned many times over in the form of operation-related savings.

But as was emphasized at the roundtable, taking the next-step--progressing to a reliability that is not longer measured in hundreds but rather in thousands of hours--will not be accomplished simply by toughening up input control and adopting a system of conditioning for finished computers. A much deeper and more expensive complex of measures is necessary. And it is not as needed at the computer-manufacturing plants as it is by the manufacturer of the computers' component base. The task is to raise the reliability level of computer technology (the so-called lambda factor) by several orders of magnitude, from ten to the minus sixth power to between ten to the minus seventh and minus ninth powers. Such a program has been developed and is now being brought to life.

Thus, the promise that has been made to consumers is well founded. All that remains now is to make sure that the necessary expenditures are made in full and on time.

Catching up requires knowing what to catch up to. This was the unexpected turn that the conversation about the technical level of computer production took.

"The word 'lag' does not sound good. Let us talk about where we are now and what we have," suggested B. Yermolayev. "Thus, in the area of functional capabilities, architecture, and software there is not more than a 2- to 3-year gap between us and the world level. This is not a distance worth discussing. Of course, we are significantly behind from the standpoint of reliability, power consumption, and overall mass and dimensions. But the problem must be examined in specific terms. Let us take the 1066 computer; it is now being put into production. Six million operations per second, completely up to standard. Disk memory must be expanded, and we will expand main memory, of course. This is a matter of engineering. Reliability? We can ensure 3,000 hours--this is from a coupling of two such computers. In terms of the YeS series in general, a program has been formulated such that by between 1991 and 1993 we will reach the world level, based on its forecast development. 'Just what is world level?" is another question. Previously we measured productivity in terms of: we have this, 'they' have that. Today we speak in terms of doing what we need to do. Our plan calls for a computer that performs 30 million operations per second. It is slated for completion in 1991 so that it can be launched into production the next year. A processor that performs nearly 750 million operations [per second] of magnitude and will make the leap from a million to a billion operations per second. This

is the prospect for the next few years. It has been carefully formulated and there is no reason to doubt that the program will be fulfilled."

I think B. Yermolayev was being a little misleading. Just what the world level of computer technology is is hardly a mystery to him. And he knows that other user features of computers, especially reliability, have developed at the same rapid pace as has speed of computation. But the accent he placed on speed was far from accidental.

For those who create computers speed of computation is something along the lines of the celebrated indices of gross output. They use it to evaluate the work of the collective, judge its professional level, and decide where to invest money for new development. Why did this come about? Because as long as computer production has existed, we have been trying to catch up. And it is hard to catch up, not every gap can be closed. Customer and developer alike have understood this perfectly well. Thus the rule: Maintain production with respect to the overall standard, and the rest can be sacrificed. This fact simply cannot be ignored, because it reflects the objective reality in which collectives of planners have developed and in which traditions and ways of formulating and solving problems have evolved. It must be remembered that we cannot get rid of this old baggage in a month or even in a year. The best confirmation of this is B. Yermolayev's remarks at the roundtable, where he announced with complete sincerity that 3,000 hours of failure-free operation is undoubtedly better than 300, but that 300 is not bad either.

[Boxed item: FACT: World practice confirms that in the recent past the reliability of computer technology has increased by an order of magnitude every 5 years and has now achieved a 20,000 to 40,000 MTTF. In the next year or two, the leading firms are planning to achieve a 70,000 to 80,000 MTTF. After that, however, the rate of growth will fall off because a natural boundary will have been reached, i.e., the service life of a machine when it is subjected to normal use.]

With time, of course, when the principles of self-financing have been worked out and the enterprise begin to count the money that they are spending to acquire computer technology and maintain it in working condition, the manufacturer will begin to feel their demands. Then, however, demands will have to be answered by actual production rather than by words. And this requires that developers begin to change their basic policies now. Now, as we see, they are defining the world level in terms of their own understanding or, to be more precise, in line with their own capabilities.

Large-scale Integrated Circuits [LSI] "Blow up" the Ministries

Until recently the computer industry had a very distinct division of labor. The Ministry of the Radio Industry [Minradioprom] and the Ministry of Instrument Making, Control Systems, and Automation Equipment [Minpribor] develop and produce computers, whereas the Ministry of the Electronics Industry [Minelektronprom] produces the component base for them. These

boundaries have now become blurred which is to say that it is very difficult to say who creates what for whom.

"About 2 years ago we abandoned our faulty effort to catch up and began to develop microcircuits ourselves," explains V. Kolesnikov. "First, we finally became convinced that by trying to catch up we were dooming ourselves to being behind permanently. In the second place, it simply became impossible to structure our operations in the old way. Previously when a designer compiled a computer from a set of our components, like a mosaic made of little pieces of enamel, he could bring us, let us say, the very latest DEC microcircuit and tell us to make the sameething. When LSI circuits appeared, not to mention very large scale integrated circuits [VLSI], the same conversation could no longer thake place. That is because before all that used to be required was to put one component in a chip; now, however, a weighty portion of a computer, a processor for example, has to be placed in one chip. Those making computers now have to have a mastery of architecture, mathematics, and design details. The result was a dead-end situation: the customer knows what he wants, our specialists know how, but in isolation neither is capable of doing the work. A solution was found in the creation of joint collectives. The outcome was positive. We are now spreading the practice; and what I feel we, the directors of the ministries, need to do most now is not interfere with our specialists."

"The technology itself demands eliminating departmental barriers and concentrating the entire complex of operations--from component base to finished computer--in one branch," believes B. Yermolayev. "In other Socialist countries, by the way, this has been understood, and analogous ministries have been united."

"Well, if the interests at ahnd really demand the creation of a unified computer production branch, then I am in favor of it," V. Kolesnikov clarified his position.

G. Ryabov did not enter into this argument. Meanwhile, it was the supercomputer designers themselves who first sensed the acuteness of the problem and first found a practical solution for it by joining forces with electronics specialists to create the joint collective whose experience is now being disseminated. For this reason, after the roundtable we asked the chief designer to state his opinion.

"I would not rush to make a decision," said G. Ryabov. "We will not increase the number of specialists thinking on a system level simply by merging ministries. And these specialists are the ones who are creating the climate today. There are between 25 and 30 persons in the joint collective. And each is worth his weight in gold. On the other hand, both our institute and the Minelektronprom institute with whom we are collaborating are the leaders in their respective branches. Accordingly, they receive the newest equipment, the most modern materials, and the latest scientific solutions. If there were one ministry, then the developers of the component base would inevitably assume a subordinate position and all of these privileges would be eliminated. It would become difficult to move forward. Well, the equality

we have worked hard to achieve in our joint collective has finally been approved. Under this type of co-subordination, I am afraid that this type of relationship would not survive either. And so two, as it were, strata of the problem arise. In and of itself, the necessity of integrating the specialists and scientific potentials of the two branches cannot be disputed. Without this, the component base for the third and fourth generations would simply not be created. The problem, however, is how to work this integration out in practical terms. To unite everyone taking part in the creation of computer technology is perhaps the simplest way. I am not certain that it is the best way, however,"

What has in fact happened? Microcircuits have appeared with a higher level of integration than before. It was a purely technical event. In our century spoiled by scientific discoveries, it may even be called an ordinary event. In terms of its consequences, however, it turned out to be extraordinary enough to raise the issue of whether to create a unified sector. So can it be something other than a matter of technology or, in any case, more than a matter of technology alone?

Speaking of bonds that should unite specialists into a unified creative collective, V. Kolesnikov was the first to speak of "human relations." G. Ryabov expressed essentially the same thought as the "parity of relations." Let us try to come to terms with this concept that is so removed from technology.

The relationships between those who create computers and those who create their component base have always been far from equal. This would be true anyway, because one group produces a finished product, whereas the other makes "small parts" that have no independent value. But the main mechanism of inequality was in technical policy itself. The mechanism acted as follows: "they" have a new generation of computers, and after some time our designers said that they could make the same computers if they could obtain an analogous component base. And that base still had to be created and launched into series production. It is well known that the development of computer technology proceeds primarily through progress in production of the component base. That is where the most complicated fundamental tasks are accomplished. In the relationships existing among specialists, however, these complications have remained "behind the scenes," and on the surface the problem has been reduced to one of "we are ready, but they are binding our hands and feet."

At the roundtable it was said that the same view had been espoused from above for decades. And it seriously hurt things in the past, too. But by the time the age of LSI came and it became clear that we could only move forward together--by puzzling together over the creation of a component base and sharing the responsibility for improving it--the established relations between the two branches had grown into a barrier so large that it could not be circumvented or surmounted. The only thing to do was tear it down.

[Boxed item: FACT: This history of the first joint collective began when the supercomputer designers destroyed the chances for their design for a

computer because they did not take into account the specifications of the electronics specialists. This laid the foundation for equality--a recognition of equality in the making of fundamental decisions. Gradually this principle became stronger and became complete from a material standpoint--joint award lists; a policy in equal rights to prizes; and, finally, appointment of several electronics specialists as chief designers in a "foreign" institute.]

The joint collective immediately established two records: it cut the time needed to create microcircuits in half and, as if incidentally, eliminated one of the flaws in our component base that had been practically considered inherent. The point is that from the standpoint of fundamental parameters--level of integration and speed--domestic microcircuits do not as a rule lag behind their foreign counterparts. But "peak" outputs have traditionally been achieved at the expense of a deterioration of such properties as reliability, noise immunity, logic flexibility, and suitability for manufacture. The following departmental principle was developed: satisfy the customer with respect to the main things, and he will resign himself to everything else. And in so doing, the "original sin" of the component base was inevitably multiplied in the design of computers. Thus in the first joint LSI the authors decided not to press for the maximal level of integration possible; instead they reduced it somewhat in favor of other qualities of microcircuits.

This is a direct consequence of the transition from a departmental-command style of cooperation to one of mutual interest in the end result. Meanwhile, the desire of computer designers to make those responsible for creating the component base their subordinates, thereby not only maintaining but also strengthening the administrative pattern that had evolved, is very evident in the proposals to solve the problem in one sweep, through a merger. It is precisely here, in our opinion, that the main contradiction of the problem lies, and it should be the first order of concern when deciding about the merger of the branches.

Melting Pot of Progress

By common consensus, our supercomputer designers have come right up to the world level. Their billion-operation-per-second Elbrus models are distinguished not only by their completely contemporary speed but also by their high reliability, capability continuous operation, and orientation toward high-level languages (which makes it possible to increase the efficiency of software production two- to fourfold). Nevertheless, G. Ryabov is postponing the time when the currently existing gap will beeeliminated until after the 13th Five-Year-Plan.

As is evident, there is a significant discrepancy in forecasts.

"It is finally time to admit it: our current lag is due to the objective fact that society did not take the risk of making very large capital investments in electronics when they were needed," announced Ye. Velikhov at the roundtable. "Now practically every branch, from the food industry to the automotive industry, has formed collectives that are capable of making electronic devices, however badly. And they all need microcircuits and

resistors, and Kolesnikov holds them all. And I know for certain that he personally distributes each unit of production equipment by telephone. Our estimates show that even if we increase the capabilities of electronics machinesbuilding fivefold by 1995, we will only be able to maintain today's current gap.

[Boxed item: FACT: When switching to a new product, plants in the electronics industry must discard approximately 80 percent of their production equipmnet. Minelektronprom enterprises develop and manufacture this equipment; they have no equal in this country. The electronics industry is the undisputed leader from the standpoint of rate of growth. Its annual growth rate exceeds the yearly production volume of analogous products by all CEMA countries. The branch processes 11,000 materials and creates approximately 80 percent of the entire value of computer production.]

Despite their importance in alleviating the acute shortage in the component base today, quantitative characteristics arennot the main ones. Far greater difficulties lie in measuring up to qualitative parameters. After all, when we speak about the necessity of overhauling enterprises' production equipment every 5 years, it must be remembered that simply replacing one piece of equipment for another is not enough. Equipment without fail must be replaced by fundamentally new equipment that incorporates the latest progress in optics and laser technology, electrochemistry, and computerization.

Materials are in even deeper source of problems. And again the problem is not that there are thousands of kinds, but rather that the majority of them should be ultrapure and have unique properties. In essence, the electronics industry collects the cream of progress from all sectors of the national economy. And obtaining the required quality of this cream very often requires starting from the very source, as they say.

Unfortunately, the worn-out principle by which a computer's productivity and the level of circuit integration were placed at the top of the pyramid while other parameters were ignored has played a large part in shaping the development of the entire electronics industry in the last two decades. When a new direction arose and a complex of measures was required to implement it, the underwater portion of the iceberg was generally ignored, i.e., that part of the progress which was not directly related to electronics (chemistry, metallurgy, and materials science).

It should be said that people are buying into the same kind of short sightedness by their failure to take offense at it; in each individual case the losses are generally measured in several percentage points. The distinctive feature of electronics is its susceptibility to multiple influences: sins pile up on top of one another, and negligible percentage points quickly begin to grow by factors and orders of magnitude. As a result our designers are forced to throw up their hands in helplessness: the leading firms have learned to place five wires on 2 1/2-mm printed circuit boards, while we cannot place more than two in the same space. They are series-baking 36-layer wafers, whereas we call 20-layer wafers an

achievement. To tackle every such leading edge (and there are dozens of them) would require turning over nearly half the industry.

Focusing attention on this problem, the roundtable participants emphasized that each step in electronics is very, very expensive. As far as the attempt to reduce expenditures to a minimum is concerned, it has been made, is still being made, and will continue to be made. There is no way out of this contradiction. To solve the problem competently and comprehensively is another matter. The electronics industry is a melting pot of the progress in computer technology. And if we set the goal of "preparing a dish" at the world level, we must be concerned with its ingredients as well as the quality of the finished product. We must not close our eyes to the dual complexity of the problem but must instead solve today's problems while at the same time tying up yesterday's loose ends.

Questions after the Conclusions

"The computer industry is now undergoing a dual restructuring," remarked P. Pleshakov in his speech. "On the one hand, there is the large-scale restructuring that the entire country is now experiencing. And of course we are included. On the other hand, there is our internal restructuring, which has been brought about by progress in computer technology itself. At such critical moments it is especially necessary to have clashes of opinions which help to more precisely formulate new tasks and ways of approaching them."

P. Pleshakov spoke at the very end of the roundtable discussion as if he had foreseen its results. Let us continue the thought that was begun by the minister.

And so the restructuring continues. This is indisputable. It is no accident that the participants' remarks echoed the refrain "in the past 2 years..."

In speaking about specific results, they should probably be divided into two types: short- and long-term results. The short-term results are clear.

As far as the ultimate goal, i.e., reaching the world level, things are less clear. According to some forecasts, this will happen in 4 to 6 years. Others estimate that it will take twice that amount of time. The pessimists tie their estimates to the state of the electronics industry, which in their view will not succeed in so quickly making up for what was neglected. It seems that their position is closer to reality if one has in mind coming out at the leading edge over the whole range of qualities, not just for individual parameters.

We must then refine our tactics for this period. Fine, let us continue to lag behind with respect to our component base for some time. In our applied mathematics, however, we are the generally acknowledged leader. A number of interesting structural decisions have recently appeared. The specialists feel that these two factors could already significantly raise our technology's resistance to malfunction, among other things, and thereby compensate for the lag in microelectronics.

Another question, which seems preposterous at first glance, arises in this context, i.e., why do we need a fundamentally modern computer? Is the reason not just to prove that we are able to do something no worse that "they" can? Once we learn how computer technology is used in our country, however, then this suggestion ceases to sound absurd.

[Boxed item: FACT: On average, only between 7 and 35 percent of the potential capabilities of different classes of computers are now used. Even from the standpoint of load, the picture is not pretty. Instead of their normative 20 hours per day, the million-operations-per-second machines only operate 13; and the more standard computers operate for 11 hours instead of the 15 called for. And this is only an average. There are record holders. In the State Agroindustrial Committee [Gosagroprom], for example, computers are used 7.9 hours per day. They are used 7.7 hours per day in the Ministry of Construction Materials [Minstroymaterial] and 7.3 hours per day in the State Committee for Labor and Social Problems [Goskomtrud].]

Having heard these data, V. Filanovskiy interjected with annoyance, "But is it not time for the State Committee for Computer Technology to think seriously about how to take computers from these users and give them to those who really need them?"

V. Bezrukov began by saying, "When I heard what great efforts are being made to achieve each step in the process of increasing the reliability and level of computer technology, I wondered whether the designers know that their computers malfunction most frequently because of fluctuations...of current in electrical circuits. That computers are often removed to avoid the inconvenience of obtaining the false floors and other materials necessary to install them. That because of the absence of a basic item like ribbon, we cannot obtain data in machine-written form. And disks...Four 100-megabyte magnetic disks are alotted for each computer. This is a laugh! Because of a shortage of peripheral memory we have computers standing idle every day."

"I could add a long list of my own complaints," said S. Bushev. "But I will not take the time. Instead I will only add one fact. We have installed computers in regional state administrations. They have received communications lines. And we send data with the help...of a telegraph. Can you imagine what torture this is or how effective our operation is? And all because there are no processors that could link our computers with the communications lines."

And these are the complaints of the directors of the largest,and, if you please, richest computer centers. What about ordinary users!

So why do we need the world level? Why are we investing enormous resources and demanding complete self-sacrifice and nontraditional thought from our specialists? Obviously so that with the help of computer technology we can obtain a victory that will repay all our expenditures with interest. We have yet to earn this feedback. Our efforts at one end of the chain are being devalued by the lack of a complete set of peripherals that would expand the capabilities of computers, by weak mathematics, by a shortage of software, and simply by an irresponsible attitude toward expensive equipment.

I will refer to the new economic mechanism again. It should bring order to this area also. But this does not mean that it is no longer necessary to save the national kopeck. As is well known, the best way to save is to spend wisely. And we need to spend in order to implement the progress attained by our mathematicians and designers so as to compensate for our lag from the standpoint of a component base. We must also spend in order to solve the set of problems related to the full-fledged use of computer technology.

It is only in this event that the course toward the world level that our industry has taken will make economic as well as technical sense.

PHOTO CAPTIONS

1. V. Kolesnikov: "If it is really necessary to create a single branch, then I am for it."

2. P. Pleshakov: "The computer technology industry is at a turning point."

3. Ye. Velikhov: "We are paying because we did not choose to make large investments in electronics."

4. I. Bukreyev: "Next year the reliability of our computer technology will increase by an order of magnitude."

5. G. Ryabov: "Merging the branches is the simplest way, but I am not certain that it is the best way."

6. B. Yermolayev: "Above all, we must understand what the world level is."

7. V. Kurochkin: "We are already guaranteeing 500 hours of failure-free operation today."

8. V. Filanovskiy: "Those who don't make good use of their computers should have them taken away."

9. B. Bezrukov: "The efforts of developers are being covered up by losses on 'trifles'."

10. S. Bushev: "We almost need to adapt computer technology to steam engines."

[From the editors. This newspaper is taking upon itself the monitoring of the resolution of the problems which were discussed at the roundtable. With the help of readers we hope to broaden the range of questions connected with the computerization of the national economy. In the near future, in particular, we intend to analyze the state of affairs with the development of personal computers and the SM series of computers, which are produced by enterprises of Minpribor.]

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International Base Laboratory for Artificial Intelligence

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[Article by K. Levitin, special to ZNANIYE-SILA: "Waves on the Banks of the Danube"; published under the heading "Science in Socialist Countries"; texts between slashes, quotes are italicized.]

[Text] /The Base Laboratory was founded at the Institute of Applied Computer Sciences, Slovak Academy of Sciences in the city of Bratislava./ --MBL [International Base Laboratory] Charter, Art 3, ¶1.

As the crow flies, Vienna is just about 70 kilometers from Bratislava, and one sometimes gets the eerie feeling of the sounds of a Strauss waltz being carried by the wind from the other bank of the Danube. Prague is farther away by more than 300 kilometers, and yet it is much closer, at least from the vantage point of MBL--the International Base Laboratory for Artificial Intelligence. That is not merely because robots don't waltz, although they have perfect hearing. More importantly, they have excellent memories, and even those just accepted by the quality inspector know that the word "robot" itself was born in the capital of Czechoslovakia. The more sophisticated of the lot, after digging in their almost fathomless knowledge base, will also recall the Prague rabbi Lev ben Bezalel, who built the clay creature, Golem, a tireless, mighty and obedient watercarrier and woodcutter, though obviously not classifiable as a "specialized robot." Only the wisest of robots (those with the word "intelligent" stamped on their identity papers) will also be sure to add that Golem had no built-in program; the program had to be downloaded into his mouth as a piece of paper with cabalistic symbols, which, as is well known, resulted in a malfunction. "The orientation toward a purely external memory is a thing of the past in robotic engineering," they would add, and for good reason.

/The Base Laboratory is authorized...to give recommendations. Recommendations are mainly concerned with scientific research activities of MBL, with a maximum reliance on international cooperation./ --MBL Charter, Art 3, ¶¶ 3,4.

From Bratislava to Budapest is less than 200 kilometers, and Hungarian television is a nightly visitor in Slovak homes. That could be the reason why, in taking leave from us, the system providing the robots with intelligence

played a few bars from Brahms' Hungarian Dance. In fact, a Polonnaise or Ukrainian folk dance would do as well: all countries of the socialist community take part in MBL activities. This is its basic feature.

The new form of integration of efforts among scientists from socialist countries was an idea that evolved over time. It stems from an international conference, memorable to many artificial intelligence experts, that was held at Repino near Leningrad in 1977.(1) More exactly, it began on a sleepless night when a few of the participants penned a letter to the USSR Academy of Sciences with a proposal to set up an international center for studies in computer technology that could bring together the intellectual potential and strengthening of our intellectual capabilities has today become an incomparably more important matter than an increase in physical capabilities. The development of a nation today can be measured by the proportion of the population engaged in various forms of information processing."

Those 10 handwritten pages may have sounded naïve, but they gave the first push, and a copy of the letter is kept carefully in a folder entitled "History" at the Bratislava laboratory. The folder also contains copies of letters exchanged by leaders of the Soviet and Czechoslovakian Academies of Sciences. The then president of the CSSR Academy of Sciences suggested that an international center could be created at the Institute of Applied Computer Sciences at Bratislava. The representative of the Soviet Academy agreed with that concept, but suggested that it be implemented step-by-step: for starters, a joint project was to be set up among scientists of the academies of socialist countries. That was in 1979; the next year, a letter arrived from the president of the USSR Academy of Sciences, A. P. Aleksandrov, suggesting that the future center be modeled on the Joint Institute for Nuclear Studies at Dubna, which has been in successful operation for many years. There are also papers signed by the vice-president of the USSR Academy of Sciences E. P. Velikhov, the former president of the Czechoslovakian Academy of Sciences V. Kvasil, and, finally, the decision of the Presidium of the Czechoslovak Academy, which made it possible for the first foreign scientists to join the MBL in early 1983. The first year there were just 10 such visitors at MBL; by the next year their number had doubled. In June of 1986 there were nine foreign members working side-by-side with Slovak scientists at the Bratislava laboratory--from Bulgaria, Vietnam, the GDR, Rumania and the Soviet Union, including this ZNANIYE-SILA correspondent.

"The idea of our laboratory is that no one is a visitor here; everybody works," said the head of the laboratory, Jozef Miklosko, on my first day there. "There is a job application for you to fill out."

/In administrative relations and production relations the Base Laboratory is represented by ITK SAN [Institute of Applied Computer Sciences of the Slovak Academy of Sciences], which bears responsibility for these relations./
--MBL Charter, Art 3, ¶ 2.

The director of ITK SAN, Ivan Plander, a doctor of technical sciences and a corresponding member of the Slovak Academy of Sciences, told me:

"The Institute of Applied Computer Sciences is the largest institute of our academy; we have about 500 employees. Almost half of our budget comes from the sale of equipment we manufacture. For comparison, other institutes of the academy receive close to one percent of their funds from that source. These results, of course, make us happy, but...after all, the institute is a scientific research organization and production as such does not do much to advance scientific thinking. This is why we welcomed the creation of the International Base Laboratory at the institute despite the difficulties this unusual unit created for us.

"We were afforded a unique opportunity for our people to devote themselves for longer periods of time to theoretical work without any administrative, organizational or business duties; furthermore, scientists here are free of their domestic responsibilities, which often take up too much of one's energy, pleasant as they may be. We take care of all of these hassles in the hope that the work of MBL will enable this institute and all the academies of science of our socialist countries to solve urgent problems of computer technology and its applications. It is obvious that today this is one of the major challenges facing mankind. Even the most powerful nation cannot achieve rapid and dramatic success by itself in the creation of new generations of computers, and so they pool their resources. The manpower and financial resources required for projects in computer technology are much larger than even the gigantic cost of space programs. The Japanese are planning to spend about a hundred billion yen on their famous project of fifth-generation computers; the Europeans, under the aegis of the ESPRIT project, are prepared to spend about $1.5 billion in its initial stage alone.

That is why we expect a lot from the joining of forces of scientists of socialist countries.

/The official language in negotiations and correspondence between the Base Laboratory and the interested agencies in socialist countries is Russian./
--MBL Charter, Art 9,¶1.

Thus, on the very day of my arrival at Bratislava my application passed through the few steps of personnel processing, and I became a full-fledged member of the staff of the International Base Laboratory for Artificial Intelligence. I was given a desk and the key to a one-bedroom apartment on the 11th floor at 4/106 Povaznov Street, and even the pay in advance for my sadly brief stay at MBL. A week of what I expected to be intense work lay ahead.

And so, indeed, it was. But those seven days also gave me a sense of communion with the unusual team of scientists, who live according to unusual rules and customs much to my linking. As a representative of an "interested organization," I was interested in the organization of work as much as in the scientific results. Indeed, how much can one "implement in hardware" in two years? But a creative atmosphere, if it is to be, should appear in the early years of work.

"What we value is not attendance but results," explained Miklosko in response to my complaint that I failed to find at their desks far from all of the

staff members he had recommended. "This rule applies to Slovak members of MBL and even more so to foreign scientists. As laboratory head my job is to provide them with conditions for work, and their job is to make the best use of these condtiions. You know, we don't force anybody to join us; there is a contest for each position, and the winners work here for three months to a year. They have to get some scientific results that they can take home. We make available to them computers, equipment and a library and, if necessary, send them on trips and encourage them to participate in conferences and workshops, but their main resource is free time. When you have to write an article, who knows better when and where to do it--you or your editor?" I decided to pass on that one.

"You see," continued Josef with understanding, "I try to stay out of the way of my people and let them work. After all, that is what a manager's skill is all about."

Certainly, I have heard this view before in various scientific organizations, but it was probably only at MBL that it was free of even a shade of posturing. Everybody was on a first-name basis, which was at first slightly startling, but in a day or two became a natural form of communication between people working together.

Generally, the Russian language as used in the laboratory is a tool helping joint work not less than, for example, computers; perhaps even more so. One easily forgives minor speech errors when the talk is businesslike. Of course, private matters people discuss in their respective native tongues.

How does one define private matters, though? I remember sitting with Petr Semenovich Sapatyy, from the Kiev Instittue of Computer Science imeni V. M. Glushkov, and listening to him as he talked about his life in science. Of course, we were talking in our native tongue and seemingly on private matters...

/The staff of the Base Laboratory consists of the permanent employees of the Institute of Applied Computer Sciences of the Slovak Academy of Sciences and individuals sent to MBL by their organizations for extended periods of time to work on scientific research projects./ --MBL Charter, Art 10,¶ 1.

"I would like to tell you why for me personally language became the most important part of work," began Sapatyy. "By education I am an electrical engineer. For a few years after college, I worked on rating and operation of electric circuits. Each such circuit is a behavioral structure, i.e., it is much more complex than a purely logical structure because it is capable of the most unexpected 'acts'--shortcircuits, breakdowns, interference, etc. I remember complaining to my father often about the difficulty of controlling complex electric circuits. My father then lived in Uman, where he was chairman of the university department of plant physiology. My father always comforted me by saying that biological systems behave in a much more complex way than do computer systems.

"Indeed, computer science studies the world at the macrolevel: organs, modules and various interconnections of the modules. A biological system, however, is always a bundle, a loop, an entanglement of connections, so that it is often hard to tell the cause from the effect. Usually, one cannot tell with any certainty what is controlled by what. I believe that this is the main difficulty in understanding biological systems. It is not accidental that when physicists delved into biology after major breakthroughs in understanding the mysteries of matter they soon realized that no blitzkrieg would be possible there...

"What theory of mathematics or physics can explain why a cut finger heals, obviously without participation of the brain, without involvement of the central processor, as we would say? A structure we build is dead compared with this elementary mechanism of living matter. A metal part does not repair itself. Nothing happens in a technical device without control, without an operating system. It is the operating system that breathes life into absolutely indifferent metal.

"What happens, though, in computers, these children of ours that we build to embody the best of our knowledge? For all their real or imagined intelligence, they are designed so that information and processing are separate; in this sense they are purely mechanical systems.

"As a result, the computer's wisdom, its intelligence, is introduced in reality entirely from outside by the programmer, who invents enormously complicated programs describing the behavior of the machine down to the minutest detail. This active program, that takes up an insignificant part of the system hardware, handles a gigantic amount of passive data--in essence, an information cemetery.

"The systems created today cope with the control of complex machinery, recognize human speech, automate the work of design engineers and 'function' as doctors, librarians, specialists in breeding and other experts, because they contain detailed integrated models of the world in which these people live and work. A modern computer, viewed as the pinnacle of human progress, thus, in terms of system organization is really at a very low level of development.

"It is paradoxical, but a fact that the computer is one of the most primitive technical devices ever created by man! Naturally, its productivity is extremely low when it does not merely crunch numbers but operates with complex models of knowledge, i.e., with the material that falls within the realm of artificial intelligence.

"This is, of course, no great discovery. In the past few years intense efforts were exerted to transform computers from giant calculators into devices capable of manipulating complex images. Much hope is pinned on so-called multiprocessor computers, consisting of a large number of independent computers: processors that can communicate with one another and handle in parallel the elements of a task distributed among them. Even these machines, however, are not suitable for the tasks of artificial intelligence."/ Fabri: There is nothing more alien to man than a robot./ --Karel Capek, "R.U.R"

"And yet, life offers us numerous examples of an entirely different organization of work involving several participants. Take a team of carpenters building a house. No one would even think of taking a house apart and giving the pieces to individual workers ('processors') so as to assemble a house from improved pieces by the end of the shift. The 'data'structure' (in this case, the house) remains in place, but the individual 'processors' are distributed throughout its volume and work simultaneously in different portions, without disturbing the topology of the whole undivided object. Translating this into computer terminology, we can say that the programs and the data are not counterposed as in modern computers, but form a combined indivisible production system. This integration, the union of programs (i.e., activities, or in this case, workers) with the data (the house structure, its topology and connections of its parts) carries today the hidden potential for the growth of artificial intelligence and, as a result, for higher productivity of computer technology. Ideally, we should approach the form of information processing observed in living nature and in social systems."

Thus, Petr Sapatyy, currently on the staff of MBL (and in the past and in the future on the staff of the Institute of Computer Sciences of the Ukrainian SSR), put forward a heretical thought: most of the efforts spent today in the development of high-performance computers will not and cannot have a qualitative or even a quantitative effect, because these computers by and large are piles of primitive calculation automata with the most elementary interconnections; their cooperation is based not on a developed internal structure, but merely on a special program introduced from outside--the so-called operating system, which bears the full burden of organizing the operation of the machine. These programs, not surprisingly, grow in size to proportions appalling even to experts and, therefore, work slowly and take up immense amounts of memory. New-generation computers, especially those for artificial intelligence tasks, should be built on an entirely new principle. Electronic engineers, even the best experts on large-, very-large- and superlarge-scale circuits, will be unable to cope with this on their own, because, ultimately, they proceed from an image of an ideally operating machine, the proverbial "well-oiled gun." The cooperative effort of scientists from the most diverse fields--mathematicians, biologists, physicists, linguists and even psychologists, sociologists and economists--thinking in diverse images and categories will be necessary.

/Once mathematics and linguistics have married each other, it is time to talk about the pragmatic side: who will do the dishes?/ --R. Filyarevskiy, "The Chronicle of MBL"

Criticism and general suggestions are welcome, but it is better to do something concrete. It would be best, of course, to make the computer "hardware" do at least part of the tasks. How can this be done?

Petr Sapatyy suggests a drastic change in computer architecture: the machine should be built as an active medium--a network of interconnected microcomputers with no central mainframe. He imagines the active medium as a sort of chicken broth in which we would throw bacteria so they could proliferate in uncountable numbers. No program as such would be entered into

the computer; the machine would serve as the structure generating the program. Elementary formulas--indications as to what should be done with available information--are simply located simultaneously at each node of the circuit. A node is surrounded by data which move towards themselves and herein lies their "volition"--the node, are transformed according to the formulas embodied in the node and move further along the circuit, modifying it in the process. "A software product propagates through the data medium and, like in a culture broth, active colonies begin to grow. In order for a computer operation to be organized in this way, the data processing should be distributed according to the data structure." These words of Petr Sapatyy first sounded obscure, but gradually their meaning began to dawn on me.

/Domin: They will never think up anything new. They could be perfect university professors./ --Karel Capek, "R.U.R."

As a matter of fact, Sapatyy is not the first scientist I heard talk in this vein. In his native Kiev, 20-odd years ago, the idea of a biological machine consisting of a large number of neuronlike elements was developed by Aleksey Grigoryevich Ivakhnenko, a corresponding member of the Academy of Sciences of the Ukrainian SSR. He described it as a "nondeterministic" computer where one could not identify the usual elements of a computer system--"information input." "memory," "arithmetic unit," etc. As he saw it, a biological machine composed of a large number of homogeneous cells will decide itself when and how many elements to activate in order to accomplish each task; the system will modify its own structure--it will self-organize--until it finds the best alternative.

Ivakhnenko, at the time the chief editor of the Ukrainian journal AVTOMATIKA, started a discussion on its pages concerning the future path of the development of computers. The question he posed was: What kind of a "thinking machine" should we build for tomorrow? What is preferable, developing the conventional universal digital computers or creating systems of a biological type? The principal opponent who spoke out against this idea at that time was V. M. Glushkov, member of the USSR Academy of Sciences, director of the Institute of Computer Science that now bears his name. Ivakhnenko was invited to join the staff of this institute and to put his ideas into practice in a creative tug of war with its director. It is true that he did not succeed; besides ideas, what was needed were inexpensive artificial neurons, i.e., devices capable of processing signals they receive; millions of such elements were needed, but not even a few were available. The idea itself, however, apparently never left the institute, waiting until a day when it would become technologically feasible...

On the same fourth floor at the Institute of Applied Computer Sciences at Bratislava that houses MBL I met Aleksey Dudko, a past and future staff member of the Computer Center of the USSR Academy of Sciences, more specifically, the sector headed by Professor D. A. Pospelov. A soldering iron in hand, he was putting the finishing touches on a pseudotransputer--a working model of a miniature device that will sit on a single silicon crystal. It is a mini-computer with all the main units of a conventional "grown-up" machine, including a large number of inputs and outputs that can be connected with the inputs and outputs of other transputers to build that very same semantic network once imagined by Ivakhnenko and now strongly supported by Sapatyy.

It was a bitter thought that real transputers rather than pseudotransputers, the transputers that are miniature devices and not a circuit taking up half a desk, can be purchased for a few dollars in any Western country. The pseudotransputer built by the Polish members of MBL and prepared for operation by Dudko (2) is just a promise or a hope; this promise, however, is not unrealistic, because located two floors below the room where this circuit sits on a desk is the division of the Institute of Appliced Computer Sciences (which will be described later) that in principle could fabricate any microcircuit, although in small quantities.

It seems that if theoreticians succeed in cooking the culture broth in which programs could thrive and proliferate, there will be no shortage of people to do the dishes. The question is whether the cooks' culinary art will rise to the challenge.

/To be completed in the next issue./

FOOTNOTES

1. See ZNANINE-SILA (No 3, 1978) for a story on that conference: "Not Shackled by Numbers."

2. The idea of a pseudotransputer itself belongs to deputy director of ITK SAN Ivan Kochishch; besides Dudko, it is being developed by the Slovak members of the MBL staff M .Gluhy and L. Cibak. Practical applications for transputers are already being planned at MBL. Valeriy Nikolayevich Zakharov, a member of the staff of the Computing Center of the USSR Academy of Sciences, has developed a set of commands that would make the transputer operate as an elementary cell of a circuit (called a semantic circuit), where it will be possible to carry out parallel logical inferences--the dream of many artificial intelligence researchers.

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Computer-Augmented Learning for Civil Aviation Engineers

18630112 Moscow GRAZHDANSKAYA AVIATSIYA in Russian No 9, Sep 87 pp 22-23

[Article by V. Z. Shestakov, doctor of technical sciences, under the rubric "At Educational Institutions": "The Computer as Educator"; first paragraph is GRAZHDANSKAYA AVIATSIYA introduction]

[Text] The perestroika of higher education has presented the problem of not only training each VUZ [Institution of Higher Learning] graduate for professional work once at the automated work station, but of placing information science and electronics at the service of improving the student's lessons while he is still in school. The development of automated teaching systems and multiple-access computer data systems, the furnishing of institutes with personal computers, and the development of computer user stations in lecture halls and departments will make it possible for students to study more productively, will help to form in them a new level of scientific and technical thinking, and will help them master methods of systems analysis and simulation and skills in the efficient processing of large amounts of information. The prorector of the Riga Red Banner Institute of Civil Aviation Engineers imeni the Leninist Komsomol, Doctor of Technical Sciences V. Z. Shestakov, talks about the experience of computerization of the educational process and of the problems that exist.

A program aimed at improving the quality of the training of specialists based on computer science and intensification of the educational process as a whole ahs been developed and is being successfully carried out at our institute. It has assumed the methods of attaining the goal set and also a balanced supply of resources for the problems to be solved.

It must be said that computer science is being introduced extensively both in the teaching process and in scientific research and the administration of the VUZ. Experience has already been gained in the use of automated teaching systems (AOS's), using both the "Vuz" unified system of computers and "Riga" minicomputers. Lessons were conducted in classes furnished with display terminals for the first time more than two years ago, for courses in computer science, programming and mathematical methods. This proved to be not a simple matter. Of course, the development of a single hour of an automated lesson for the computer requires of the developer from 50 to 500 hours of teaching, methodology and programming work. The development of a

single course for a discipline is estimated to represent a total labor of five to six man-years. And since standards for this kind of teaching work simply did not exist until recently, the successful employment of automated teaching and testing of knowledge was achieved primarily because of the initiative and enthusiasm of the associates of the department of automation and computer science, headed by Dean E. Ya. Peterson. As of the present year computer facilities began to be used in administering the USSR Air Code test by the institute's permanent staff.

Automated courses have been introduced in many of the country's VUZ's now--at the aviation and energy engineering institutes in the capital and at the Belorussian and Leningrad state universities and others. We are in close contact with our colleagues and we ourselves try to adopt the advances they have made in this field.

However, negative factors have been evidenced in addition to positive trends in the use of automation and electronics in the teaching process. For example, after mastering the fundamentals of working with computers, some teachers began without justification to do away with traditional teaching methods and shift a great part of the lessons to classrooms furnished with display terminals. But according to the latest recommendations, the amount of educational material to be studied by means of computers should not exceed 30 percent on average.

Scientific methodological and scientific research work on the use of computers in the teaching process is being done at the institute. It is oriented toward the development of new techniques for solving teaching problems and toward an analysis of the actual state of affairs. This year we are conducting a wide-scale experiment in keeping records of the actual time each student works at a terminal--both during lesson hours and independently at the computer center and in departments. The results we are waiting for will make it possible to make solid decisions relating to improvement of the use of computer facilities for individual disciplines, specialties, departments and the institute as a whole.

On what do we lay hopes for further improvement of the teaching process? First of all, on the formation of a sufficient number of classrooms furnished with terminals, and providing special departments with personal microcomputers for the automation of calculations and the organization by active experimental and scientific research work by students. At the same time the extensive introduction of various kinds of professional games is planned, which simulate the professional work environment of future aviation specialists. Bookkeeping practice has already been developed at the institute based on SM-4 minicomputers, and there are functional trainers that simulate the operation of complex aviation systems.

Another trend is the use in the teaching process of computer-aided design systems. The department of electronic radio equipment for aviation is playing a leading role here. A classroom was equipped with an IZOT minicomputer last year in the department of theoretical radio engineering, headed by S. A. Bukashkin. Two more classrooms are in line to be furnished with the most up-to-date computer facilities.

Without dwelling in detail on questions relating to the use of computer facilities for administration of the VUZ, I will mention only the fact that here too we have begun experiments in the development on a new basis of fragments of "Vuz" automated administration systems. The task has been set of automating recordkeeping functions at the dean's office level. The first Dekanat [Dean's Office] subsystem has been put into experimental operation in the department of automation and computer science. It has been implemented on an SM-4 minicomputer located at the institute's computer center with the use of peripheral devices situated at the work station of the assistant dean of academic affairs. The interactive entry and receipt of required information at any time during the work day will make it possible to improve considerably the efficiency of the administration of lessons in departments.

Our institute is rendering considerable assistance to schools in the field in the area of computerization of the teaching process. For example, methodical instructions have been published for the development of automated educational courses in the "Riga" AOS [Automated Teaching System], and a textbook is being readied for publication in conjunction with the Riga Aeronautical Engineering School. The most promising work is being circulated through the computer center.

But computerization of the teaching process is not an end in itself. The principal task is the training of aviation specialists able after graduation from the VUZ to operate aviation and ground equipment successfully. Therefore, we are constantly and purposefully strengthening our ties with scientific and production subdivisions and are taking part in the training and retraining of personnel. For example, a training center is opening at the institute for improving the skills of personnel in using the Sirena-2 system for the sale and reservation of flight tickets. The first group has already completed training. Our cooperation with the TsNII ASU GA [Central Scientific Research Institute of Automated Control Systems for Civil Aviation], the Riga Educational and Training Center and other civil aviation organizations has been very fruitful. The retraining of specialists in working at automated work stations is under way. Fragments of ASU's [automated control systems] functioning in the field are being introduced into the teaching process.

At the end of the 12th Five-Year Plan period, we plan to have increased 10-fold the total amount of computer time received by each student during his education, and 5-fold the number of seats in classrooms furnished with terminals. The laboratories of all departments will be furnished with microprocessor computer facilities and personal computers. All this will certainly make it possible to raise to a qualitatively new level the training of engineers for Aeroflot.

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Classifiers and Documents

18630091 Moscow KLASSIFIKATORY I DOKUMENTY in Russian No 10, 1987 pp 1-27

[A collection of brief articles on product and document classifications and codes and related research and development projects published monthly by the All-Union Scientific Research Institute of Technical Information, Classification and Coding [VNIIKI]; issue prepared by the Main Scientific Research Center for Maintenance of All-Union Classifiers, 2880 copies, 28 pages]

[Text] I. Information Software for ASU [Automated Control Systems]. General Problems of Classification and Coding and USD [Unified Documentation System]

UDC 002:65.001.56:681.3.01

"Standardization of the Information Component in Systems for Computerized Processing of Product Data," by N. ' Fedotov, candidate of technical sciences, A. K. Beresnev, candidate of technical sciences, R. A. Sergiyevskiy and V. A. Sokalsky, GNITsVOK [Main Scientific-Research Center for Maintenance of All-Union Classifiers] [pp 1-7]

Standardization, unification and classification of products and the management of industrial quality and nomenclature largely depend on the development of methods and tools of computerized data processing.

The creation of a general standard for the All-Union Classifier of Industrial and Agricultural Products [OKP] and a system for managing and using this classifier is an absolute prerequisite to develop and introduce a standardized computerized system that would collect, process and retrieve data on products and the related technical documents for industrial classification, coding, standardization and unification at all levels of the economy, from national to local enterprises and organizations. Such a system would require that a functional and economic description of each product listed in the OKP be entered into a computer and processed, yielding identification, a comparative analysis and an evaluation of the technical level and quality of the product.

The mammoth effort needed to build a system of this size (more than 20 million product items), the need to meet the interests of a very large group of users,

to apply the information for diverse purposes without any drastic change in basic plans, and to process and exchange data rapidly through a computerized network all require that a universal, systemic approach be taken. It is important to unify computerized systems of product information processing, especially the information components of such systems.

The unification process calls for reducing the diversity of computerized systems for processing product data by introducing a set of systemic facilities functionally equivalent to earlier single-focus systems. A unified automated information system should be devised for a long term perspective; it should be a basic model with the possibility of various modifications by inclusion of new specialized (unique components. The unified information components of such a system should be independent of the object of description, the form of the information source and the user application programs; it must be usable in any subject field whose objects are described by compatible data structure.

Data processing is understood here as the set of procedures (operations) on input data yielding new data, i.e., data not present explicitly in the initial file. Elementary data processing operations are a comparison of two values, calculation of the average, summation, etc.

A data processing operation always involves an object (the input data) and the results of processing; combined with the description of the data structure and other systemic elements, these operations form the information component of data processing.

The general requirements for a uniform information component in computerized data processing are stated as follows:

--the ability to set up a common data bank integrating a set of distributed independent databases used in execution of application tasks, reciprocal information exchanges and network processing;

--elimination of data redundancies at the input to the computerized data processing system (hereafter referred to as the system);

--minimum system response time to user requests, as enhanced by the data structure and file organization; and

--user communciation with the system and presentation of output data (end results) in natural language and a structure established by canonical rules at the system level.

The approach to unification of the information component described below is based on a common formal structure for input data.

The set of objects described by the system is finite; each object has properties expressed by the appropriate attributes. The connections between objects (relations) are also described by sets of attributes. The attributes of objects (parameters, characteristics, indicators, etc.) can be measured objectively, evaluated and described; they are said to be the data on these objects.

Each attribute (including the name and conventional notation) assigned to an object is regarded as a unit fact--an elementary event.

The formal description of an event is a finite information group--a message.

A message is an ordered sequence of symbols combined in groups (words) or single symbols; a message has a specific internal structure, beginning/end symbols and symbols that are unique to the message describing the particular object. The selection of messages relevant to an object makes up the description of that object; it is defined as the basic data storage unit--or document.

A message can be simple or complex. A message with data on a single unconditional event (a characteristic, a requirement or an indicator) which pertains to a single object is said to be a simple message; for example, "an amount of inert impurity not greater than 0.3 percent."

A complex message contains data:

--about a single event relevant to several objects (for example, "the amount of inert impurity is 0.7 percent for the first specimen, 0.5 percent for the second specimen and 0.3 percent for the third specimen");

--about a single conditional event relevant to a single object (for example, "direct current of 20 V at a temperature not less than 20°C and a pressure not more than 0.8 kg/m^2");

--about several events pertaining to a single object (for example, "rated and minimal relay activation current are set in the technical specifications").

A complex message may or may not be linked with other messages. In the above examples, unconnected messages were given. The columns and rows of a table are examples of connected messages.

A message is formulated in natural language and consists of:

--name of event (descriptive attribute);

--conditions under which the attribute is defined;

--message structure (simple or complex); and

--value of the attribute for the given object of description.

The names of attributes and their conditions may recur (individually or in groups) in the descriptions of various objects. Objects with fully coincident sets of attribute names are said to be homogeneous (with respect to description). The name of an attribute (together with its dimensionality) is treated as an independent message--the constant component of the attribute description. The constant components of attribute descriptions are combined

into a separate document: the constant component of the description of an object (a group of objects) designed by the symbol "OC." Each attribute name is assigned a code, unique within the system, which can be used in combination with any object described.

An attribute value combined with its code forms a message which is the variable part of the attribute's description. The variable parts of attribute descriptions are also combined into a separate document: the variable part of the description of a specific object, denoted by "OV."

The constant and variable parts of the descriptions of objects have the attributes of independent documents; within a database they become units of storage linked in a specific way.

The above examples of OC and OV structure have the following (simplified) form.

OS	OV
Amount of inert impurities, %	First specimen -- 0.7 Second specimen -- 0.5 Third specimen -- 0.3
Direct current voltage at temperature $\geq$20°C and pressure $\leq$0.8 kg/m^2, V	20
Direct current voltage, V	20 at temperature $\geq$20°C and pressure $\leq$0.8 kg/m^2
Activation current	Rated, minimal--indicated in the technical specifications

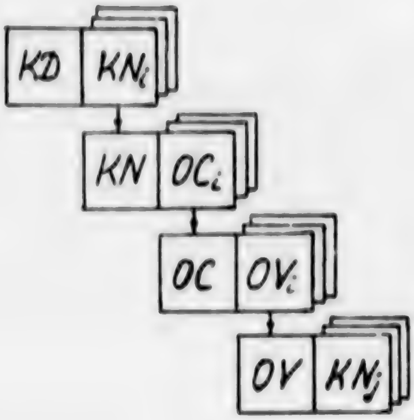
Messages in this structure are encoded in two phases:

1) word-by-word coding of the textual part of the message using the system dictionary;

2) assigning to the constant part of the message a unique system code KN_i ($i = 1,\ldots,R$, where R is the number of attribute names in the database).

This coding system minimizes the redundancy of input data and allows automating these procedures with relatively simple means.

The associative connections of information files in the system are constructed as shown in the diagram:



The following notations are used: $j = 1,\ldots,L$, where L is the number of messages in the object description, and KD is the descriptor code for the textual part of the message.

It is obvious that in this system a direct search is not required in order to retrieve the desired data, thus reducing the data for selection and retrieval time in the execution of application tasks. This method of unification of the data in computerized data processing helps standardize the software.

This universal, formalized structure for input data thus determines the specifics of design for a computerized information system, including the logic structure. For data and files this approach to automated information processing, along with the dictionary and the data description language, can form the structurally standardized elements of the information component of computerized data processing system. The introduction of these attributes endows the system with these unique properties:

--the ability to represent any properties of objects that can be expressed by quantitative attributes (characteristics, parameters and indicators) and connections (relations) between objects. This approach is helpful in the design and comprehensive standardization of products and in modeling the various aspects of industrial operations;

--minimal system response time to a user request for data search and selection, thus improving the opportunity for real-time use;

--a high level of automation of system functions, including multistage automatic coding of input information;

--the ability to develop standard design concepts and duplicate them in various fields where the objects have a universal formal representation;

--the ability to prepare input data and execute various computational algorithms, i.e., to solve all kinds of application problems;

--the ability to develop centralized and distributed databases and use them independently in two-way communications or network information processing; and

--the ability to revise and update data (both on objects and their parameters) and to integrate data to any desired level.

The implementation of these principles will help develop in the Soviet Union an integrated (universal) information base and software for computerized classification, coding, standardization, unification and control of product nomenclatures, technological standards and quality.

UDC 002:681.327.2:65.011.56

"Maintenance of Reliability, Currency and Comparability of the Technical and Economic Data Bases of Industry Automated Control Systems," by S. B. Zinger, T. S. Karepina and G. I. Sheveleva, VNIPIOASU [All-Union Scientific Research and Design Institute of Specialized Automated Control Systems] of Minpribor SSSR [USSR Ministry of Instrument Making, Automation Facilities and Control Systems] [pp 7-12]

Improved efficiency of ministries and effective use of sectorial ASUs [OASU] as a tool of economic management can be achieved by building the information component of these automated systems into databanks; the databanks should include both general-systemic and problem-oriented databases and local area networks of personal computers.

The informational integrity of the system is essential in the design and operation of OASUs. To achieve this, certain steps must be planned and taken to ensure the comparability (consistency) of units of measure in such areas as control systems, nomenclature, planning categories, accounting periods, and economic significance of these units.

Methods of attaining this goal based on the practical experience of the ASU for the instrument-making industry are described below.

Data consistency for control systems can be achieved by developing a common methodology for measuring structural changes in the industry. As the industry switches to a two-level management structure and as the details of this structure are worked out, various changes are taking place (more than 30 types of changes), in particular:

--merger of two or more enterprises;

--absorption of an enterprise into a production association or subordination of the enterprise to a production association without it becoming an integrated part of the association;

--transfer of enterprises from one subgroup (organized according to the principal types of products manufactured) into another subgroup;

--splitting of production associations into independent entities; and

--elimination of an enterprise or association (its transfer to a different ministry).

Structural changes in the industry must be taken into account in comparative appraisals of indicators for two periods, in retrospective analyses of the activities of a control system, in investigating why information has not been entered into the system and in some other situations. The procedures for measuring the structural changes in an industry that are used in the execution of tasks and for database maintenance are regulated by a special set of system-level instructions addressed to the departments that write up task descriptions and overall planning decisions; these instructions are also addressed to departments of the computing center, that supervise the execution of tasks and database management. Depending on the task, the unit of technical-economic measure and the kind of structural change, the new and accumulated data can be used in various ways. The time factor is significant (the time of change, such as the middle of the month, the beginning of a quarter, etc.).

A user deciding whether a structural change should be reflected in a report must have exhaustive data on the change. Such data can be obtained from a dictionary-directory of structural changes included in the database and formatted as a general system dictionary.

The entries of the dictionary-directory are compiled on a centralized basis in a group of dictionaries at the computing center based on orders from the ministry. The code of the facility is the entry code in the dictionary-directory (either a newly assigned code or an existing one, depending on the kind of structural change). The informational part of the entry consists of several features:

--the codes of the old enterprises (for a newly formed enterprise resulting from the merger of several enterprises);

--date of entry;

--code of the type of change;

--code of the new production association;

--code of old production associations; and

--identification number and date of ministry order.

The type-of-change code is taken from the table included in the general system instructions.

This format of entries of the dictionary-directory makes possible the automatic link-up with the appropriate commands (operators) in the application programs and the management utilities programs. A single structural change can trigger the following operations on the various data.

1--data eliminated for the particular enterprise;

2--data retained under the old code;

3--data retained under the new code (data transfer);

4--data values summed for the given enterprises;

5--data values reduced by the value of the enterprise that has left the PO; and

6--data values increased for the PO by the value of the respective indicator from the newly affiliated enterprise.

Other operations on the data are also possible.

The procedures for measuring structural changes in the industry are spelled out for each particular type of data in a special section of the task description or description of system-level planning resolutions concerning data bases.

The foregoing method of measuring structural changes in the industry with the use of the system-level dictionary-directory has been used in retrospective analyses of the measured effectiveness of a control system (several years earlier) and in the execution of tasks taking into account the changes during a period (a quarter or a month) immediately before a reporting period.

The data consistency for product names was achieved by the use of the All-Union Classifier of Industrial and Agriculture Products [OKP] as the information base of all dictionaries, data sets and database segments where product codes may appear. The control system keeps a system-level dictionary of end products; the entries of the dictionary give the codes and names of products manufactured currently or in the past by the enterprises in the industry. Entries for newly launched products are regularly entered into the dictionary. As of February 1987, the dictionary consisted of approximately 75,000 entries.

The comparability of plan data among the various subsystems can be achieved through the use of a common nomenclature of product categories and types of labor; this would be an adequate nomenclature for the economic plan for the industry. Annual production plans of enterprises and organizations and reports on the fulfillment of these plans should be formulated on the basis of a common nomenclature. It should also be used in five-year plans, comprehensive economic analyses of enterprise activities, calculations of labor costs, average weighted material use quotas, etc. The common nomenclature is updated when new product categories are entered or old ones are eliminated from the national economic plan of the industry. The names and codes of the product categories in this common nomenclature are usually adopted from the names and categories as they appear in the classification section of the All-Union Classifier of Industrial and Agricultural Products [K-OKP]. If the categories in the national economic plan for the industry do not match the OKP classification, they are assigned a code in the "zero" categories according to an established procedure. The common nomenclature of product

categories is maintained in the form of a centrally-compiled system-level dictionary. The various subsystems can thus rely on a common information file.

The consistency of data on economic significance, accounting period, maximum number of characters in an identifier (length of segment field), unit of measure, etc., is achieved through centralized calculation of technical-economic indicators used in the system. Descriptions of indicators are kept in the form of a thesaurus with standard format for entries and the lists from the All-Union Classifier of Technical-Economic Indicators [OKTESP]. The thesaurus registers the correspondence between the identifiers for technical-economic indicators in an input document (form, line and column) and the semantic (and therefore invariable) code appearing in OKTESP. As a result, the information base can remain stable even when the input form is changed or when the same indicator appears in different types of input documents (different forms). The thesaurus gives the address of an indicator in the system: database, segment and field where the value of the indicator appears. With centralized maintenance of the technical-economic indicators the duplication of indicators can be avoided or minimized and conditions are created for complying with the requirement of one-time data input and multiple and multivariant data use.

The reliability of information entered into the system is assured by formal and logical verification; these functions are performed by system-level programs and special programs adjusted to specific tasks. Experience has accumulated in the development of a system-level database of input messages, which is organized and maintained by the software package SSD-ES. The arrival of information through communication channels into the system is monitored in the database as a dynamic process. For effective correction of the incoming messages, access to the database is afforded to both the enterprises supplying data and the groups at the computing center. All the messages received at the database are put together, verified, corrected and forwarded. The results of forwarding are affected by data reliability. If some enterprises have not submitted information or have submitted information in the wrong format, no reliable totals can be obtained.

The updating of problem-oriented databases includes the updating of dictionaries used in the logical structures of databases and changes in information to accommodate the organizational changes in the industry or for other reasons.

A general system database of normative-reference information (DICTIONARIES [SLOVARI]) is maintained as a precondition for reliable, current, and comparable information in an integrated OASU; another precondition is informational interaction of the database with other OASU components, including the components of the local area networks of personal computers.

A systemic approach to development of an OASU and its informational integrity can be provided only if the system-level information component is created in advance. Even at the early stage in the project, instructions, classifiers and other documents should be distributed to the participating departments; these documents spell out the general principles of development of the information component of the OASU being created, the classification system and

the coding, the procedures for the use of unified document forms, the procedures for development and use of system-level and local classifiers and dictionaries, the databank structure and the specifics of the development of tasks whose solutions require use of the information stored in the database.

Supplements to the output documents are distributed as separate information sheets to subsystem supervisors and other staff members participating in system development and operation.

All descriptions of problem statements and general system design solutions must be coordinated by the department of information programs as a way of organizing these activities.

II. Development and Introduction of Classifiers and USD

UDC 025.4:65.011.56:681.1:626.8

"Features of the Classifier of Subsystems and Task Sets in the Automated Control System for Land Reclamation and Water Management," by L. G. Goruleva, candidate of technical sciences, VNIPIekonomiki [All-Union Scientific Research and Design Institute of Economics] Minvodkhoz SSSR [Ministry of Land Reclamation and Water Economy of the USSR] [pp 12-16]

The departmental classifier of subsystems and task sets of the Automated Control System (ASU) of Minvodkhoz SSSR was created to ensure information coherence and unification of terminology in descriptions of the sets of tasks to improve the efficiency of system operations. When the classifier is compiled early on in the development of an OASU [specialized automated management system], the functional and organizational structure of the management of the industry, especially when it is being formed, can be defined clearly and unambiguously. By defining the informational relationships of subsystems and sets of functions, it becomes possible to avoid duplication of algorithms and programs when the detailed design of the OASU is prepared.

Land reclamation and water management is a relatively new industry; therefore, describing the structure of informational relations helps define the main management functions of the subsystems and determine the development prospects of the industry and ways of improving management. The main areas of operations are, on the one hand, water management and land reclamation construction projects, including civil and industrial engineering construction and, on the other hand, operation of land reclamation and water management projects, i.e., irrigation and drainage systems for improving productivity of reclaimed land.

These factors determine the features of the classifier of the subsystems of the OASU for land reclamation and water management. Fourteen subsystems are included in the first stage of the OASU:

Code	Subsystem
00	Support subsystem
01	Planning and economic management
02	Construction management
03	Management of operation of hydromelioration systems
04	Management of comprehensive use and conservation of water resources
05	Industrial production management
06	Design and exploration management
07	Management of material and technical supply
08	Management of mechanization and transport
09	Scientific and technological progress
10	Financial management
11	Labor and wage management
12	Personnel management
13	Management of administrative and legal aspects
14	Accounting and recordkeeping

Functions at all levels of management in the industry were classified in greater detail according to objectives and functional features and organizational subordination to water management construction agencies and agencies responsible for operation of reclamation and water management projects.

The departmental classifier was developed in conformity with the All-Union Classifier of ASU Subsystems and Sets of Tasks. On this basis OASU tasks were classified in a rational way and the number of tasks minimized. In many subsystems use of the classifier has made it possible to shift to a standardized, and thus substantially faster, form of task planning. The main subsystems for the first OASU stage were defined according to the functional characteristics of the activities of the central offices of the ministry.

The sets of tasks were defined in terms of the same features. A task code reflects the ASU type and the management level. Tasks are combined into sets according to a homogeneous management function and connection between processes with regard to their input and output data.

Information on the functions of the ASU of Minvodkhoz SSSR to be included in the classifier was submitted according to an officially approved format.

A task code consists of 10 digits; it is structured as follows:

X X XX XX XX XX

- Management level
- Activity type
- Subsystem of the ASU of Minvodkhoz
- Set of tasks in the subsystem
- Task in the set
- Control number

A code consists of two parts: the information, or classification, component (the first two digits), and the identification component (digits 3-8).

The first digit indicates the applicability of the task to the various management levels in the organizations of the ministry. Digits 2-6 represent the structure of the codes of task sets.

The last four digits, including the control number, were assigned on a centralized basis--by the industry's classifier maintenance service; the information was then transferred to the industry's computing center and added to the list of classifier operations to be performed by computer.

Before the final decision on including a task the classifier was made, the information from the ASU developers was subjected to terminological analysis and additional information on the tasks was requested. The tasks were matched against the list of tasks in the All-Union classifier and correlated with the various functions and management levels in Minvodkhoz.

Defining the final lists of tasks for the classifier and coding them was difficult mainly because some of the subsystems are themselves sets of interconnected ASU subsystems, organizations and administrations. For example, the "Construction Management Subsystem" includes functions such as "Accounting and Recordkeeping," "Labor and Wage Management," etc. This subsystem can be isolated as a separate complex system: "Management of Preparation for Construction Operations."

The informational component of the code reflected the following data: level of management at which a task (set of tasks) is accomplished, ASU type (ASPR [automated control system for planning calculations], ASU of a basin, ASUP [automated control system], ASUTP [automated system for industrial processes], etc.), type of information (i.e., the type of task or set of tasks accomplished--accounting, management, monitoring, planning, prediction or optimization) and periodicity of the execution of a task (or a set of tasks).

Currently, only data on the management level and ASU type are included in the informational component of the classifier.

The first digit of the code indicates the management level (or several levels) at which the information is used and the task is executed. The following management level codes are used:

0--national;

1--Minvodkhoz;

2--regional industrial management administrations and ministries of water management of the Union republics;

3--construction trusts, production associations and other organizations subordinated to regional main administrations;

4--mechanized mobile crews, enterprises, etc.

5--all management levels at which the task in question is accomplished;

6--the first two levels at which the task is accomplished; and

7--the last two levels at which the task is accomplished.

Types of ASU (second digit), depending on the sphere of production activity, are denoted by the following codes:

1--automated control system for planning calculations [ASPR];

2--automated control system for construction control [ASUS];

3--automated control system for agroindustrial complex [ASUAPK];

4--automated control system for industrial enterprises (production of articles from reinforced concrete, construction materials industry) [ASUP];

5--automated control system for industrial processes [ASUTP];

6--automated control system for water management (river basins, large canals, hydroengineering structures, etc.) [ASUVKh];

7--automated control system for operations management (irrigation and drainage systems, water management boards of oblasts, rayons, etc.) [ASUE];

8--computer-aided design system [SAPR];

9--automated control system for science and technology, scientific research, scientific and technical information, etc. [ASUNT];

0--ASU covering all types of activity.

The identification portion of a classifier code consists of the serial numbers of task sets (within subsystems) and of individual tasks (within the sets).

The divisions of the classifier have been developed on the basis of a study of recommendations submitted by subsystem developers (taking into account the OASU technical assignment and the annotated list of tasks for the OASU-Minvodkhoz system), a list of ASU tasks performed by computing centers of ministries of water management of the Union republics, main administrations subordinated to All-Union ministries and cumulative data on the functions of the ASU obtained from the Main Information Computing Center of USSR Minvodkhoz.

The informational part of the classifier code of an object carries additional information on a task (or a set of tasks) of the OASU of Minvodkhoz. This information can be used to study OASU functions as a way to make a rational choice of mathematical software and perform computerized operations according to schedules.

UDC 025.4:001.4:061.5

"Rules for Abbreviation of Names of Enterprises and Organizations," by N. I. Boyarshin, candidate of technical sciences, and T. M. Babenko, Glavniivts [Main Scientific Research, Information and Computing Center] of USSR Gosplan [State Planning Committee of the Ukrainian SSR] [pp 17-20]

Experience with the use of the All-Union Classifier of Enterprises and Organizations [OKPO] in integrated databanks [BnD] and in interactions of ASUs [automated control systems] of various levels indicates the desirability of having an abbreviated form for the names of organizations, as well as the full names included in the OKPO.

Names of entities in the OKPO are noun (nonverbal) statements consisting of words and phrases, usually with no abbreviations. These are said to be full names.

In a republic-wide, industry-wide (departmental) or local classifier, abbreviated names of enterprises and organizations are used. The following principles of name abbrevaiation are suggested. Abbreviations are obtained by replacement of words and phrases in the full name and by elimination of redundant information from the full name.

Abbreviations are the principal form of name contraction. Abridged names are used in vocabularies of data description languages [YaOD], request languages [YaZ] and names of fields of databases to reduce the computer memory requirement and optimize the arrangement of data in tables displayed or printed by the output device. Abridged names of enterprises and organizations should appear in interindustry, industry, republic and local classifiers.

The following requirements are imposed on abbreviated names: uniqueness and semantic completeness; uniform use of standard and common abbreviations; minimum rendundancy; and avoidance of synonyms.

The uniqueness of an abridged name of an organization implies that it must have semantic features to distinguish the entity from other entries in the classifier. If there are not enough such features, additional features from the full name should be included.

Abbreviations recommended by standards and terminology dictionaries should be used. In absence of a standard abbreviation of terms or where several alternatives are possible system conventions must be adopted; to encourage use of these conventions, official lists of abbreviations are compiled. The abbreviations in the names of entities should comply with the grammatical rules and standards of the Russian language.

Redundancies arise where an abbreviated name includes more features than are necessary for a unique designation of the entity. For example, "Lvovselmash" [Lvov Factory of Agricultural Machinery] (correct); "Lvovselmash" Farm Machine Factory, Lvov (incorrect); the features specifying location and type are indicated twice in the latter version.

Synonyms should be avoided.

The following typical structural elements are isolated from the full name to standardize the abridgement process and to generate formalized names: enterprise type (O); proper name of the facility (N); type of product typical for the facility (P); and territorial location (T).

The type of enterprise in the name of a facility can be described by a word or a phrase. Abbreviation is the usual method of name reduction.

If the type is expressed by one word, a common abbreviation agreed upon by system convention is used: for example, zavod [factory] = z-d; institut [institute] = in-t.

If the type of facility is expressed by a phrase, abbreviations by initial letters or by morphemes are formed: for example, proizvodstvennoye obyedineniye [production association] = PO; stroitelno-montazhnoye upravleniye [construction and installation administration] = SMU; lesnoye khozyaystvo [forestry administration] = leskhoz; gosudarstvennoye stroitelstvo [government construction] = gosstroy.

The proper name of a facility may include a designation of the industry type, N_P, and a designation of the territorial location N_T.

If necessary, proper names within the name of a facility can be omitted: for example, Lenin Order Institute of Cybernetics of the Academy of Sciences of the Ukrainian SSR imeni V. M. Glushkov = IK AN USSR.

The proper name of a facility may include a designation of the kind of industry and the location in a morpheme-based abbreviation: for example, Lvovselmash Factory. Names of this kind are not to be abbreviated.

The type of production in the name of a facility can be described by adjectives, such as "machine-building facotry," "knitwear factory," or by a noun: for example, "PO of railroad car building," "factory of relays and automation."

In forming the abbreviation of the product type from a word that can be truncated, as many letters as possible should be dropped: for example, mashinostroitelnyy [machine building], mashinostroiteln., mashinostroit. (incorrect), mashinostr. (correct).

When the shortest abbreviated version may interfere with comprehension, a longer form should be taken: ffor example, nasosnyy [pump-related], nas. (incorrect), nasosn. (correct).

When the Cyrillic "short i" [y] precedes the omitted fragment, the next consonant should not be dropped: for example, kaliynyy [potassium] = kaliyn., liteynyy [foundry] = liteyn.

If the dropped part of the word is preceded by a double consonant, one of the consonants should be retained: for example, turbinnyy [turbine] = turbin.

The designation of location in the name of a facility is specified either by adding a modification to the main word T_a or by including the location in the name of the enterprise T_b or by specifying the village or city name T_c.

The semantic templates for abbreviations are based on the typical elements that make up a name.

Each semantic template type can consist of up to six subtypes formed by a rearrangement of the elements in the abridged name.

A study has shown that of 42 possible types of semantic templates only the following are accepted: T_oOP, T_aPO, OPT_b, OT_bP, OPT_c, POT_c, T_aON_p, OT_bN_p, ON_pT_c, OPN_t.

An extended algorithm for forming abridged names of facilities using conventional (unautomated) procedures consists of the following steps: analysis of the full name, selection of a semantic template, determination of the typical elements of the name, formation of the abridged name, verification.

A dictionary with most common abbreviations for each semantic template, the types of facilities, and acceptable abbreviations for various types of facilities, based on product made, has been compiled to help improve the efficiency in creating the abridged names and to achieve uniform terminology.

The above principles have been employed in the development and introduction of instructions concerning the formation of abridged names of enterprises and organizations for republic-wide, industry-wide and local classifiers of technical and economic information into the ministries and administrative departments of the Ukrainian SSR.

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"Quality Assessment of Design Documents," by A. N. Konoplev, MosgorTsNTI [Moscow City Territorial Center of Scientific and Technical Information and Propaganda] [pp20-23]

Quality of design documentation, particularly documents stored in the files of Union republic institutes of scientific and technical information [RINTI] and interindustry regional centers of scientific and technical information [TsNTI], is becoming increasingly important.

These organizations keep files of design documents for nonstandard equipment. In [1] a new computer-oriented specification format for design documents for nonstandard equipment was described, which was introduced to help accelerate the pace of new research and development projects.

The present paper describes the principles for evaluating the quality of design documents submitted for inclusion in the files of TINTI and TsNTI.

A study of the relationship between the number of requests for design documents in the files of RINTI and TsNTI and the qualitative characteristics of these documents has shown that a given physical quantity can be defined as a single-valued function of one or several variables. A relationship of the type $x_1 = f(x_1)$ is called a pair relation; one, of the type $x_1 = f(x_1, x_2, \ldots, x_n)$, a multiple relation.

Theoretically, the accuracy in the solution of each problem can be improved infinitely by including more and more groups of factors from the more important ones to the less significant ones, but as a result the solution of a problem becomes too cumbersome. For evaluating the quality of design documents kept in RINTI and TsNTI files a matrix method is used that organizes the basic quality features of design documents.

From the set of design documents in the files of Moscow City Territorial Center of Scientific and Technical Information and Propagands [MGTsNTI] only those were selected for the matrix analysis which had been reported in industrial innovation newsletters (other publications were disregarded in design document quality evaluations).

The following features of design documents were included in the matrix: the size of the document set; author's certification; participation in an exhibition; number of analogs; cost-effectiveness; number of requests for the design documents; and a coefficient of technological development level [KTU].

A matrix of 550 elements was processed to determine the relationships between the number of requests and the qualitative indicators of documents and to select a criterion quantifying the quality of design documents.

The first five features relate to the dependent variable, whose purpose is to express the quality of the selected design document.

In order to find a criterion quantifying document quality, we must make a transition from several dependent variables to one. This is done by a method of taxonomic analysis.

The taxonomic relation of an object to itself is defined by the formula

$$t_{yy} = \frac{S}{n}\sum_{i=1}^{n}(1/B_i) - 1, \qquad (1)$$

where S is the number of objects; n is the number of features; and B is the number of objects having a given feature.

The value of t_{yy} is defined by the occurrence frequency of features. The taxonomic relation in this case is interpreted as the coefficient of the technological level of the design documents.

For a study of the correlation between the number of requests and the variables identified, scales must be constructed for the quantitative variables; nominal variables should be introduced for qualitative characteristics. A nominal variable takes two values (0 and 1). The range of variation of a feature is divided into intervals.

Size Scale of Design Document Set

Set size (number of AI sheets)	0-6	7-22	23-44	45-66	67-88	89-154	Above 154
Number of sets	53	35	11	3	3	2	1

Economic Effect Scale

Economic effect (in rubles)	0	0-1000	1001-7000	7001-13000	Above 13000
Number of sets	82	12	10	3	1

On the basis of formula (1), the KTU was evaluated. The table gives the data on the request frequency K_{av} of a document set as correlated with the technical development level coefficient.

KTU	Number of sets	Number of requests	K_{av}
0-2	40	247	6.175
3-4	49	367	7.49
5-10	9	52	5.77
Above 10	9	33	3.67

The results show that the maximum number of requests corresponds to a KTU of 3 or 4. At a KTU less than 3 and more than 4, the number of requests declines; at KTU = 10 it drops abruptly.

The results can be interpreted as follows. At KTU = 2 the product is virtually of no interest to consumers, because it has an analog.

An increase in the KTU indicates a growth of interest in introducing the product, because the application sphere of the new product is expanding.

With a further increase of KTU the application scope of the product narrows down, and its introduction becomes more difficult because of its uniqueness and/or the large amount of work involved (labor or material cost).

In selecting design documents for the files of RINTI and NTI the value of the KTU should be taken into account; this coefficient estimates the probable number of requests, which is helpful for improving the circulation of design documents and efficiently using the information service potential to spread the latest industrial developments.

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UDC 025.4:65.011.56:681.3

"The Use of Bar Codes in Foreign Countries," by I. V. Marshakova, candidate of technical sciences, GNITsVOK [Main Scientific Research Center for Maintenance of All Union Classifiers] [pp 23-27]

The New York research firm FIWD/SVP has published a state-of-the-art review of the bar code industry [1]. For the 1990's a 20 percent groth of bar code equipment programs and systems is predicted. In 1985 the sales of bar code products amounted to $600 million to $700 million.

The projected growth of the bar code industry is based on the fact that bar code systems help resolve one of the difficult problems in computerization: data input. Bar codes are a natural choice for computers where frequent

input of large amounts of data are necessary. Despite the tremendous potential of bar codes, this industry cannot grow faster than the industries it serves.

A bar code is a symbol consisting of a distinct pattern of bars and spacings identifying a binary notation of letters, numbers or other symbols. There are more than 50 bar code systems; only a few have become widespread.

Four principal bar codes are currently used extensively; they are shown in the figure [2].

1. The Universal Product Code [UPC] (see figure, item a) is commonly used by retailers. A product is denoted in the UPC system by a 10-place number specifying the manufacturer and the amount purchased.

When a UPC code is read from a label the price and name of the product are converted by the computer into the price to be paid by the customer.

2. Code 39 is the most common bar code for documentation processing used by the U.S. Department of Defense. Items b, c and d in the figure show Code 39 bar codes of high, medium and low density, respectively.

Compared with UPC, Code 39 carries alphabetic as well as numeric information; a code sequence can be longer than a 10-place number and is limited only by the decoding power of the reading device. On average, a Code 39 consists of 24 characters. Practice has shown that the reading of Code 39 symbols has an error rate of one error per 3 million symbols.

3. Interleaved 2-of-5 code is shown as item e in the figure.

4. Codabar code is used for numeric information processing. A library Codabar code is illustrated by item f in the figure.

The main applications of Interleaved 2-of-5 code and Codabar are U.S. air parcel post and the documentation for circuit assembly at Hughes Aircraft (United States).

Bar codes have several advantages: a drastic reduction (by five orders of magnitude) of the number of erros in information input as compared with keyboard input; ease of reading of bar codes by electronic optical scanners as compared with alphanumeric characters; the high cost-effectiveness of systems based on bar codes and devices for information storage in a digital form (in systems that previously preferred microfilms and microfiches because of the high cost of manual keyboard data input).

For the reading of a bar code a small light spot scans the sequence of symbols; a sufficient amount of free space (the so-called free zone) is allowed to the right and to the left of the code sequence. Contact and remote scanners are used. Contact scanners are built as a light pen or a light stick that is moved over the surface of the code. Remote scanners use a laser or another optical beam to read the bar code. The contact method is

UPC Version A

0 12345 67890 5

a)

Code 39 Low Density

12345

d)

Code 39 High Density

12345

b)

Interleaved 2 of 5

12345

e)

Code 39 Medium Density

12345

c)

Library Codabar

12345

f)

less expensive; although the contact reading technology requires some skill, an operator can learn how to use a light pen in a few minutes. The advantage of the remote method is the possibility of reading bar codes from cellophane surfaces or other nonuniform surfaces which are difficult to handle by contact devices. An additional merit is that remote reading does not damage the label, allowing multiple readings. Scanners can also read codes through a transparent package. The operation quality depends on the input optical system and the decoding algorithm.

Bar code generation programs are being developed intensively. In [3] a program generating Code 39 symbol standardized for the U. S. Department of defense is described. The program is written in Basic language and is designed for a microcomputer (a personal computer). The program prints bar codes as lines of variable thickness and density, combined with the printing of additional information lines. A bar code can be printed with variable density depending on the proposed application and the type of scanner. The complete text of the program adapted to an IBM-PC is given in [3]. The program is written for an Epson printer, although it could be easily adapted for other printers.

Automatic Identification Systems (AIS) to identify bar codes have been developed. These are systems which read data and convert them to the desired form for subsequent computer processing.

A study by the firm FIND shows that the bar code technology is popular because of the following features:

--high reading accuracy and speed;

--standardization potential;

--flexibility (bar codes can be rapidly read from a distance of several feet; manual and stationary scanners can be used; devices identifying automatically the code system of a bar code are available);

--easy use (minimal training);

--relatively low equipment cost;

--optimal size (compactness of symbols, their flexible position and the fact that they are not affected by magnetic fields); and

--easy code verification; the symbols are self-checkable and can be verified visually;

Bar coding equipment can be combined with a keyboard and allows the operator to read the input information.

In 1987 there were more than 300 bar code equipment suppliers, ranging from small companies with several employees making special equipment (electric circuits, programs, etc.) to companies with thousands of employees building complete bar code systems with startup services and maintenance. The bar code industry numbers many small companies with revenues of a few million dollars, several medium-sized companies with sales in the hundreds of millions and a few very large companies with gigantic revenue figures. While most smaller companies concentrate entirely on bar code systems, the medium-sized and larger companies are engaged in other projects as well.

Development trends in the bar code industry in the past few years include mergers of smaller companies and takeovers of small companies by larger ones with a net result of a reduction in the number of firms engaged exclusively in bar code operations. Smaller companies usually supply components for bar code systems.

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UDC 331.101.1:62.001.66:681.3:766

Computer Graphics in Ergonomic Design

18630003 Moscow TEKHNICHESKAYA ESTETIKA in Russian No 9, 1987
(manuscript received 3 Dec 86) pp 10-13

[Article by A. M. Kudryavtsev, candidate of technical sciences, Leningrad State Pedagogical Institute imeni A. I. Gertsen]

[Text] Improving quality and reducing the time needed to develop designs is one of the most important tasks of graphic design. In connection with this, the problem of creating and using computer-aided design (CAD) systems assumes first priority.

In order to solve various ergonomic problems which take the human factor into account as a qualitative production indicator and consider man's psychological, physiological, anthropometric and hygienic characteristics, work is being carried out to create a problem-oriented computer-aided design system [2,3,5].

Figure 1 represents the structure of an ergonomic CAD system which includes the following subsystems:

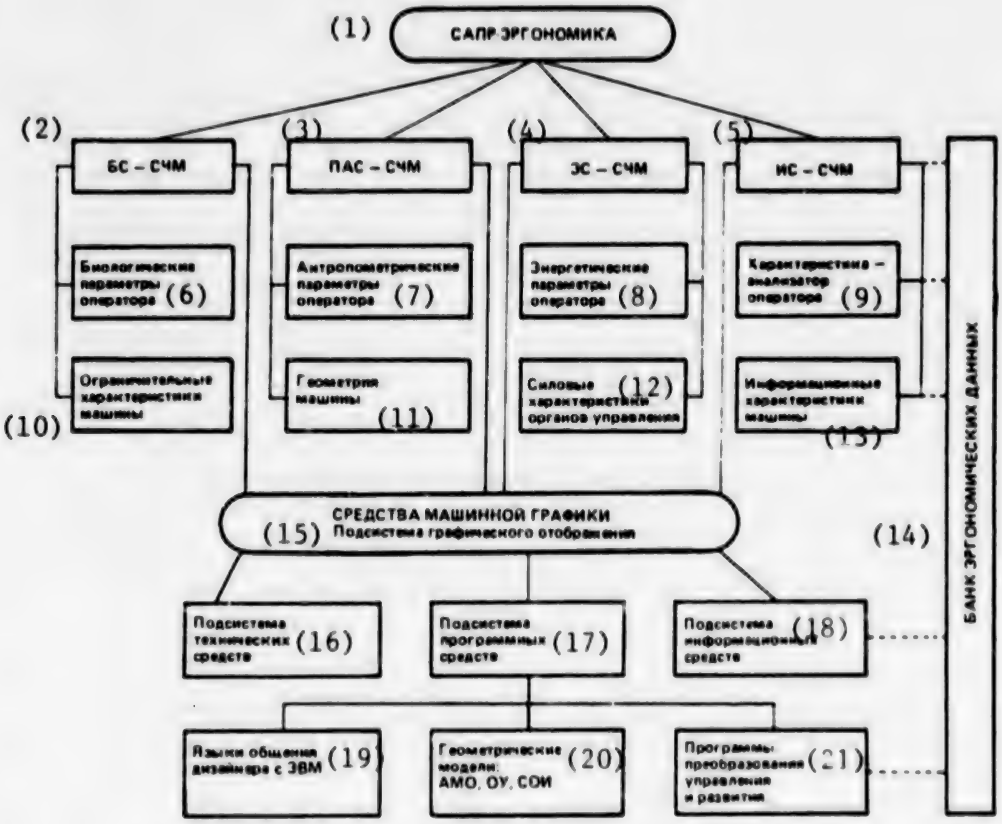
BS-SChM: a subsystem for biological compatibility within "man-machine" systems (SChM), which helps solve problems in ensuring an optimal correlation between the operator's physiological condition and working ability, on the one hand, and factors of the environment and the machine, on the other, i.e., nominal and maximal parameters of the microclimate (temperature, humidity, pressure, radiation, etc.) around the operator and the machine parameters (vibration, lighting, acoustic environment) are established with regard for the operator's psychophysiological abilities;

PAS-SChM: a subsystem for spatial-anthropometric compatibility of the operator with the machine in an SChM, which helps solve problems in creating the three-dimensional structures of objects in civil and industrial construction, industrial equipment, workplaces, etc., on the basis of anthropometric characteristics;

ES-SChM: a subsystem for energy compatibility between the operator and the machine in an SChM, which helps solve problems in designing structures and controls in accordance with human energy potential, that is, according to applicable strength, speed, accuracy, expendable power, etc.;

IS-SChM: a subsystem for information compatibility between the operator and the machine in an SChM, which helps solve problems in designing information displays on the basis of psychological characteristics (visual, aural and other sensory capabilities).

Figure 1. Ergonomic CAD System Structure



Key:

(1) Ergonomic CAD System; (2) BS-SChM; (3) PAS-SChM; (4) ES-SChM; (5) IS-SChM; (6) operator's biological parameters; (7) operator's anthropometric parameters; (8) operator's energy parameters; (9) operator's sensory parameters; (10) machine limitations; (11) machine geometry; (12) force characteristics of the controls; (13) information characteristics of the machine; (14) ergonomic data bank; (15) Computer Graphics System--graphic display subsystem; (16) hardware subsystem; (17) software subsystem; (18) information management subsystem; (19) designer-computer interface languages; (20) geometric models: anthropometric model of operator, controls, display; (21) control, development, and conversion programs.

Development of the ergonomic subsystems for computer-aided design is being held back by the inadequacy of the standardized operator characteristics for creating a mathematical human model which will be the base of the ergonomic CAD system.

Ergonomics research is being performed using two groups of methods: design and experimental [9]. The design methods of ergonomic product engineering are used today essentially at the draft stage when deciding the basic configuration and when selecting an area for locating display equipment and controls. The experimental methods, used for the practical development of ergonomic designs, are related to the development of experimental and functional models and to the creation of actual production conditions, which in turn entail great difficulties and expenses. It is estimated that the amount of labor involved in the ergonomics aspect of designing a product comprises 15-20 percent of the total labor devoted to design [9]. Therefore, it would be more justified to perform ergonomic product engineering by using computerized design methods.

The use of computers in ergonomics mathematical modeling studies is finding increasing support at home and abroad. A great deal of the work is oriented toward modeling the activity of the operator in making decisions concerning control. Let us note an advantage of such mathematical modeling, which allows the expression of ergonomic aspects from the moment of the program's conception, and not at the very end, in an attempt somehow to include the person in the system.

However, it is common knowledge that the results of ergonomic research are being applied by designers with some difficulties--the form of representation of ergonomic data, which is far from the models with which the designer is accustomed to working, is a handicap. Therefore, geometric models formed on the basis of ergonomic parameters will serve precisely as the medium through which designers will naturally take the human factor into consideration in their work. Geometric models comprise the basis of graphic design documentation and contain a large mass of information, the processing and representation of which are expedient via computer graphics.

The computer graphics system in a general computer-aided design system is a graphic representation subsystem which, in turn, contains subsystems for hardware, software and information management (fig. 1).

The development of mathematical models based on ergonomic data is the most useful feature in ergonomic design. The most standardized group of such data represent the anthropometric features of the human body, which can also be taken as the basis for a mathematical model of the operator. This model for depiction on the display (plotter) should have a geometric form. Geometric models of the operator are, as a rule, two-dimensional human models, used in the design methods of ergonomic research, and three-dimensional human models, used in the experimental methods.

Existing anthropometric methods for designing man-machine systems are oriented toward the calculation of anthropometric features through the schematic representation of the operator. Therefore, the more anthropometric features (static and dynamic) embodied within the model of the operator, the more precisely it will reflect anthropometric characteristics in design work and, in the final account, in the product designed.

Spatial-anthropometric compatibility (PAS) of the operator with the workplace elements (the equipment) in man-machine systems incorporates the design of surface position of the operator's body, and surface position of controls and information displays on the basis of motor fields, fields of view, and calculation of the relevant parameters.

The solution of PAS problems by known anthropometric design methods [7] goes through four stages (fig. 2):

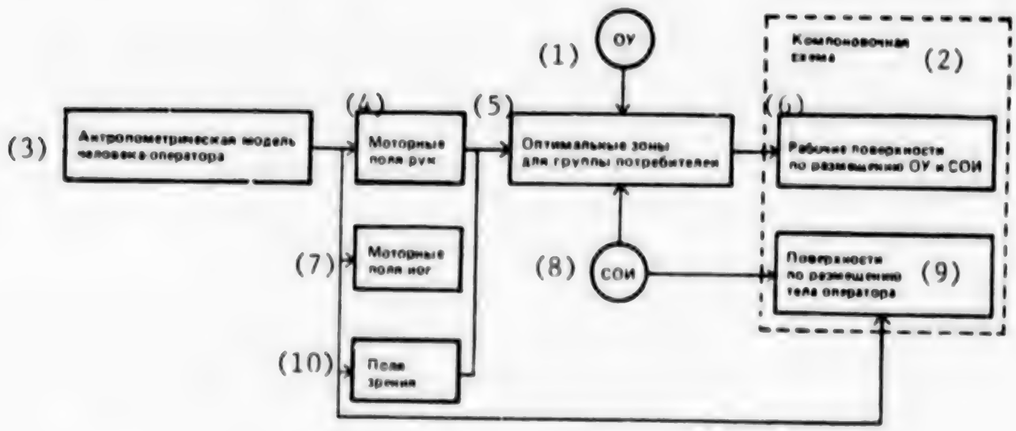
Development of an anthropometric model of the operator on the basis of anthropometric data;

Determination of hand and foot motor fields and field of view ranges for standard postures;

Establishment of optimal work areas for a group of users (standard and intermediate working postures);

Development of a layout plan, i.e., location of surfaces with respect to the operator's body, the controls, and the information displays based on calculation of the relevant parameters.

Figure 2. Stages in the Solution of PAS Problems in Designing a Work Station (Equipment) for SChM



Key:

(1) controls; (2) layout plan; (3) anthropometric model of operator; (4) motor fields of the hands; (5) optimal areas for groups of users; (6) work surfaces with respect to control and display layout; (7) motor fields of the feet; (8) displays; (9) surfaces with respect to position of the operator's body; (10) fields of view.

All anthropometric methods of design can be arbitrarily divided into three groups according to the method of calculation of anthropometric parameters: somatographic, calculated, and experimental (fig. 3).

Figure 3. Anthropometric Design Methods

Key:

(1) Anthropometric workstation (equipment) design methods; (2) calculated methods (algorithmic); (3) experimental methods (model making); (4) somatographic methods; (5) somatography; (6) two-dimensional human model method; (7) geometric vector-coordinate method; (8) design graphics, application method.

Each group of methods has its own faults ar isadvantages in solving PAS problems.

In order to solve the first stage of PAS problems the somatographic methods represent the human body using engineering graphics, two-dimensional jointed models or animation methods. Because of the high labor-intensiveness of schematic representation of the human body via engineering graphics methods, the authors of the projects reduce the first stage of solving PAS problems to computing the "average person's" anthropometric parameters, which is also done when using two-dimensional jointed models. The faulty concept of an "average person" is used also when representing the human body through animation.

Besides losing the human geometric form, the calculation methods use an excessively limited number of anthropometric features.

Three-dimensional human dummies, which are used in the experimental model methods, in some cases include a sufficient number of anthropometric features, but they can be used only with models of the objects being designed and only for a visual evaluation.

The second stage in solving a PAS problem, which is designing the work areas, is possible while remaining within the anthropometric model of the operator, but with questionable accuracy when using engineering graphics methods and even more questionable when using two-dimensional human models.

The third stage of solving PAS problems is related to the design of optimal work areas for a group of users and to the necessary analysis of standard and intermediate working postures. The graphic design method permits only visual analysis in view of the detachment of the human photomodel from the formation of sensory and motor zones. The remaining methods do not provide for the analysis of intermediate postures, except for the experimental methods, which are not always economically justifiable.

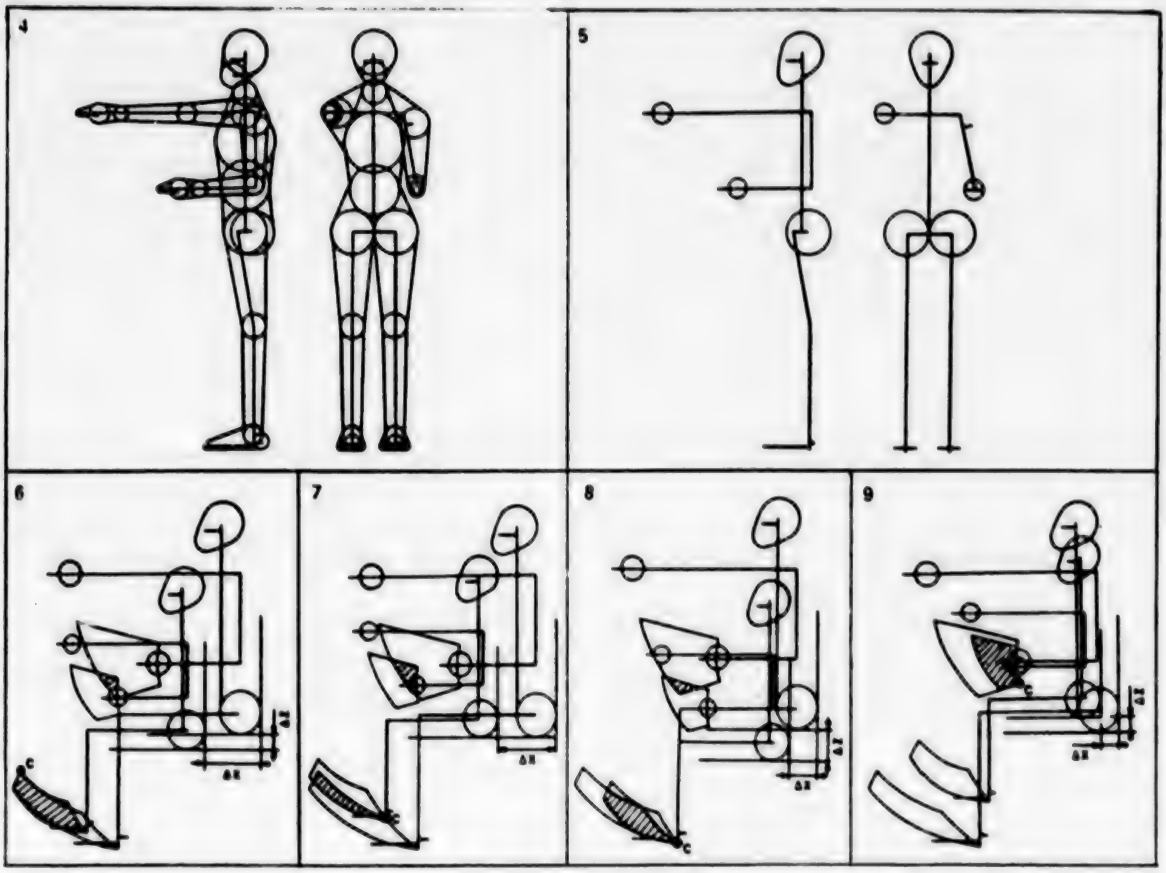
The fourth stage in solving a PAS problem, which consists of the determination of surface positions of the operator's body, controls, and information displays, is not taken into consideration by the design methods. The experimental methods are implemented, as stated in the method textbook [6], "using the construction of full-size rigid models of specific products out of lumber, etc.... Rigid models differ little from the products themselves except for the technology by which they are produced." In other words, the surface geometry is reduced to a planar solution. What is meant today by work surfaces should be understood to refer only to planes, since methodological principles for modeling work surfaces based on the operator's motor activity are lacking.

In summation, the essential shortcoming of the enumerated anthropometric methods (with their individual merits) lies in the complexity of practical calculation of the entire diversity and variety of anthropometric features, in the impossibility of analyzing and modeling design solutions for workstation elements (equipment) in man-machine systems according to multiple criteria. All these methods are "manual," being based upon engineering graphics, model-making and animation methods, which are now becoming obsolete.

What does the graphic analysis method [5] offer? It takes into consideration the merits of the three enumerated methods and, operating within a computer graphics system, permits us right in the first stage of solving a PAS problem to consider the diversity and variety of anthropometric features (in the VNIITE Anthropometric Atlas) through the formation of an anthropometric model of the operator (AMO). In order to make a three-dimensional form of the AMO it suffices to assign four parameters: sex, ethnicity, percentile, and age, as a result of which 44 anthropometric criteria are considered in the model with a precision of up to 1 centimeter. The geometric model of the operator is depicted on the display or through a plotter as jointed or approximated models (fig. 4). The time for output to the display is 3 to 7 seconds. The jointed geometric model of the operator permits us to use the AMO both in "standing" and "sitting" working postures.

To solve the next stages of a PAS problem, the geometric model of the operator is used as an instrument for modeling the sensory and motor areas with respect to the layout of controls and information displays.

Figures 4-10.

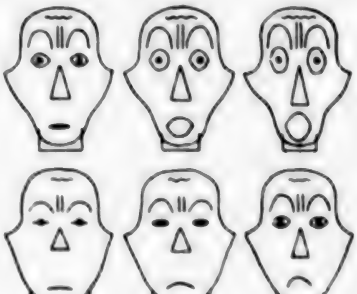


Key:

(4,5) Geometric model of the operator: approximated and jointed.

(6,7) Examples of designs for creating shared work areas for a group of users: 6--foot controls; 7--hand controls.

(8,9) Examples of designs for creating shared work areas for a group of users. Hand and foot controls are shown: 8--advantage of using foot controls; 9--equivalency in the use of hand and foot controls (Conditional designators: delta x and delta y are the regulating parameters of the work seat in a frontal plane, c is the point of overlap).



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(10) Example of computer graphics use: by choosing from among various numerical values for the characteristics, it is possible to control facial expression.

The modeling of optimal working areas for hands and feet and of maximal reach is implemented on the basis of dynamic ergonomic parameters [4,8] with calculation of the "increase" in the length of the arm in different positions. The design of shared work areas for a group of users is implemented in interactive mode depending on the controls (fig. 6,7).

Further development of the graphic analysis method for ergonomic modeling of man-machine systems depends on the standardization of ergonomic characteristics in a mathematical model of the operator. A number of a person's physiological characteristics are directly expressed through his facial features, which can be reproduced on a display for operational observation of the condition of the operator or his model. The "Litso" [Face] system, intended for the synthesis of experimental physiological data, which are multidimensional information on the formation of facial expressions [1], was developed at the USSR Academy of Science's Leningrad Scientific Research Computer Center. Stylized representations of nine human emotional states, which are achieved through changes in curvature of the eyebrows, mouth line, degree of openness of the eyes, etc., were created by Japanese specialists Yamashita and Hara [10] on the basis of 17 parameters on a graphic display (fig. 10).

The possibilities of computer graphics and, in particular, of interactive graphics, are not limited by design automation--they are extensive and are limited only by the imagination. Thus, at the Leningrad State Pedagogical Institute imeni A. I. Gertsen, work is being carried out in the use of personal computers (Iskra, Yamaha) as a technical teaching aid in the course "Technical Modeling and Design," in the section on "Basics of Ergonomic Design."

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Prospecting Systems Based on Electrical and Seismic Telemetric Microprocessor Instruments

18630113 Moscow EKONOMICHESKOYE SOTRUDNICHESTVO STRAN-CHLENOV SEV in Russian No 10, 1987 pp 40-42

[Article by Aleksandr Yuskovets, journalist, USSR: "Computers Search for Oil"]

[Text] Gloomy forecasts by researchers studying the future, relating to the rapid disappearance of fossil resources and of oil in particular, appeared in the pages of the world press approximately 20 years ago. There was talk of the fact that by the year 2000 practically none of it would be left in the interior of our planet. It would appear that in this case geological exploration for this strategic raw material does not have to be improved. Is this so? In fact, it has as yet not been possible to find large deposits of oil. But this does not mean that a tomb stone should be placed on the available deposits.

Of course, the time of the "golden fountains" is past. But that is why even small reserves of oil located deep in the earth in non-traditional caverns cannot be disregarded. Exploration conditions have also become complicated. Besides, exploration for mineral resources today intensifies the problem of protecting the environment.

That is why such great attention is being paid in the entire world to the development of new methods of geophysical prospecting and of high-efficiency tools capable of conducting a purposeful, more reliable search for oil and gas deposits. This problem was reflected also in the Integrated Program for Scientific and Technical Progress (KP NTP). Scientific teams of CEMA member countries are working on its solution. Two large instrument systems should be the result of their combined work: a seismological multichannel telemetric microprocessor prospecting system (TMSMS), and an electrical multichannel telemetric microprocessor prospecting station (TsES-TS).

Of what significance are these systems? How is interaction between scientists of various countries taking shape? We requested answers to these questions from Candidate of Technical Sciences Sergey Fedotov, Doctor of Technical Sciences Igor Bezruk and Candidate of Technical Sciences Yevgeniy Grachev, associates of the All-UnionScientific Research Institute of Geophysics, one

of the leading subdivisions of the Neftegeofizika Production Association--the head organization for these problems of the KP NTP.

The instrument systems to be designed according to its assignments will go into the Geos information measuring and processing system that is being developed in the USSR and will cover practically the entire spectrum of prospecting for fossil resources.

Its components speak for the comprehensive nature of the Geos system. For example, the system provides for space-based geological and spectrozonal surveys of the earth's surface by means of artificial earth satellites; laser detection and ranging on our planet; photographic geological mapping; aerial gamma spectrometry; and aeromagnetic, aeroinduction and aerogeochemical surveying. There is also work at sea using television photographs, sonar and seismoacoustics. Finally, there are ground-based kinds of prospecting for fossil resources, including drilling and gravitational, magnetic, seismic and electrical prospecting.

Questions arise: Why were new methods of seismic and electrical prospecting needed in particular? What about existing instrument systems did not suit geophysicists?

It turns out that today the data obtained in the course of these kinds of prospecting and recorded on magnetic media are transmitted for express processing to expeditionary geophysical computer centers (GVTs's), or, for more thorough processing, to regional GVTs's furnished with more powerful computers.

Thus, the obtainment and processing of information are separated in time and space, and this means that geophysicists lack the ability to control field work as it is being conducted. This results in unjustifiably great losses of time and effort: Vast expanses end up being studied in too great detail, including those not containing deposits. Exploration can be conducted purposefully and effectively only on the basis of data gathered instantly and processed on a computer.

That is why the need arose for a computerized exploration technology taking into account current trends in the development of geological prospecting in the world.

However, before introducing multichannel seismic and electrical prospecting systems into practice, it is necessary to develop a large amount of accompanying equipment. This includes sources of vibration and equipment for channels for the rapid transmission of geophysical information, and various kinds of microprocessing equipment.

Among the most important problems facing scientists are the management and processing of enormous streams of information. Today 200 computers each having a capacity of one million operations per second are required for processing seismic prospecting data. And about 2000 of these computers will be needed as early as in the next Five-Year Plan period. And if electrical

prospecting is added to this, in the course of which the environment is studied, then the capacity of a single expeditionary computer center must equal 2×10^8 operations per second!

Thus, according to the scientists' summation of the problem, the processing of geophysical data can be solved by either the creation of superpowerful expeditionary computer centers, or by radically changing the data processing technology. The second way seems more practicable, until the appearance of reasonably priced supercomputers. This is why it has been proposed to introduce the express processing of geophysical information based on the microprocessor equipment with so-called multichannel data collection. The processing of data directly under field conditions will make it possible to carry out purposeful exploration. This means that the reliability and effectiveness of geophysical information will improve considerably.

The more thorough processing of geophysical data must be done by powerful computers. Geophysical data obtained from complex geological environments will also be interpreted by these more powerful computers.

The use of microprocessing facilities and satellite communications will make it possible to restructure radically today's technology of gathering and processing geophysical data.

But now let us talk about what functions the instrument systems to be developed in accordance with the KP NTP will take on. For example, the field seismic recording system will be able to do the following:

Make a complete diagnosis of the seismic channel, including a check of its key parameters.

Record data on magnetic tape in the prescribed format.

Control the source of seismic energy.

Make static and kinematic corrections.

The introduction at seismic recording stations of microprocessors and microcomputers is making it possible already today to implement some of these functions; in particular, to make a complete diagnosis of systems, which facilitates monitoring of their operation and the quality of field data.

The next step in the development of the seismic prospecting technology is the development of a unified field module for gathering information, as well as a unified system for communication between field modules and the on-board computer system. In the final analysis, the flowchart for a multichannel microprocessor seismic prospecting station should look as follows: first, a uniform network of unified field modules which receive information directly from geophones; then the conversion of this information into digital form and the subsequent transmission of it by wire or fiber optic communication line to the station.

The introduction into practice of a TMSMS using 250-500-100 channels and a TsES-TS using 100 channels will result in a considerable increase in labor productivity in geological prospecting.

But how is cooperation between the specialists taking part in the completion of the KP NTP's assignments taking shape? Let us ask our friends frcm the Institute of Geophysics.

"As yet, the signing of the contracts is going more slowly than could be desired," they answer. There are reasons for this. They are the complexity of the equipment to be designed and the lack of experience in international cooperation, and the lack of a detailed mechanism for interaction between the head organization and its colleagues on the project from CEMA member countries.

This is why it has not been possible up to now to conclude a single contract with all the countriesddeveloping the TMSMS and TsES-TS systems, and to define fully the partners' interests in the end results of the cooperation.

However, contracts have already been prepared for individual components of the systems, and joint research will begin in accordance with these contracts. For example, the field module is being developed by the Neftegeofizika NPO [Scientific Production Association] and the Scientific Research and Engineering Technology Institute of Automation (IPA) and the Enterprise for Geological and Geophysical Prospecting (IPGG) in Rumania. The specialists are to complete the electronic "guts" of the modules and the communication and diagnostic systems, the digital part, and also to develop the software for the field modules and communication system.

As research has shown, the majority of the components for the analog processing of signals in the field modules cannot be selected from the already prepared list of industrial products. They must be developed on the basis of thin-film technologies.

It is quite obvious of how great importance the speed of the transmission of information from a field module to aboard the station is. Therefore, special high-speed communication lines must be arranged. These will possibly also be developed by Soviet engineers together with Rumanian colleagues from IPA and IPGG.

The next important problem in designing the multichannel systems involves the development of on-board on-line buffer storages. They are needed for the intermediate storage of information. The memory capacity for field information-gathering systems in the seismic recording system has reached about 40 MB. The designing of solid-state storage devices for this purpose is a very difficult problem, but is totally solvable.

Today's system of recording the data from physical observations on magnetic tape also does not satisfy engineers. The fact is that the available storage devices cannot cope with the enormous streams of information. The recording density for systems using these storage devices must be increased by a factor of eight as a minimum!

Specialists of the Bulgarian firm Izot are working on the development of up-to-date magnetic tape storage devices. Engineers from the GDR's Geofizika People's Enterprise will probably join them.

The contribution of the Hungarian partners is quite significant. In particular, an agreement has been reached with the electrical industrial products firm Kontakta, which will supply chassis, stands and laboratory equipment for the future systems. The firm Labormim is making for the on-board stations unified laboratories with air conditioning, designed for working under the most complex climatic conditions Videoton's participation in the development of a unified version of a color graphics display for seismic and electrical prospecting is being coordinated. And specialists of the State Geophysical Institute imeni Tvesh Lorand are developing special-purpose processors.

The central recording system is being developed by the joint efforts of scientists of the All-Union Scientific Research Institute of Geophysics; the Computer Center, Siberian Division, USSR Academy of Sciences; Robotron (GDR); and Videoton. And the Czechoslovak enterprise Geofizika will take part in developing the system for the determination of coordinates.

"As you can see," the scientists conclude the discussion, "the amount of scientific research and experimental design work that our countries' specialists are obliged to perform is very great, and the tasks are very complex. You know, as early as 1991 we together with our colleagues must arrange the specialized production, on a cooperative basis, of two instrument systems."

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Rules and Procedures for the Creation and Circulation of Design Data Files on Magnetic Media Under the Unified System of Design Documentation (YeSKD)

18630061 Moscow STANDARTY I KACHESTVO in Russian No 9, Sep 86 pp 20-22

[Article by Yu. B. Fratkin, candidate of technical sciences, A. S. Tretyakov, candidate of technical sciences, I. M. Yakubovich, candidate of technical sciences, and K. V. Novikova: "Rules and Procedures for the Creation and Circulation of Design Data Files on Magnetic Media under the YeSKD"]

[Text] At the current stage of the technological revolution, computers have been introduced on a large scale in various spheres of the national economy. A major way of improving productivity is by replacing menial, routine, and low-productivity work with the work of intelligent and versatile computers. Flexible manufacturing systems are to play a key role; they are comprised of state-of-the-art equipment, control facilities, robotic systems, computer-aided design systems [CAD], computer-aided manufacturing, [CAM] and others.

No substantial acceleration in production can be achieved if computerized systems are introduced in an uncoordinated fashion: under such circumstances a lot of "manual" work has to be invested to prepare input data for coding. The automated systems for various purposes must be combined into integrated networks, and program interfaces and a common databank have to be created if a qualitative leap in productivity is to be achieved by various groups of workers in planning, management, and production.

Information interaction among automated systems, primarily CAD and CAM, is the most urgent problem in the development of integrated systems.

Automated manufacturing and quality control are dependent on a database formed during the course of computer-aided design. Much more detailed data are needed, however, for control and monitoring of the manufacturing process than are produced by CAD systems.

Today, CAD data are usually entered manually into a CAM database. To avoid waste of time in interoperational transfer of data from the CAD system to CAM and, if necessary, in the opposite direction, [a unified database containing all the necessary information to support both product design and the

planning of manufacturing processes must be created.] Such methods of data transmission are only feasible, however, between automated systems using similar types of hardware.

For systems based on different types of hardware the informational linkage can be accomplished by transfer of data files on magnetic media or transfer of information through communication lines. Currently, the former option is easier to implement.

Documentation on magnetic media is not an entirely new idea. However, according to existing notions of how that should be done (according to the standards now in effect), the informational contents of the documents on paper and on magnetic medium must be identical, i.e., the documents can only differ in the form of data representation on the medium. This means that information from a set of blueprints is assigned on the magnetic medium in exact conformity with its appearance on the physical document. This approach can be called the "assigned form of recording."

In contrast to the assigned form, the authors propose a method for conveying the results of design that can be called, by way of convention, an "integrated form of recording." Information is not tied to the physical appearance of the document. The data of a magnetic file can thus be used not only to retrieve documents, but for other industrial applications, such as planning of manufacturing processes. With this form of recording, duplication is eliminated and automated modification of records is simplified. This is the main advantage of the integrated form of document representation when incorporated into computerized Design and Manufacturing systems.

The magnetic medium with the data file describing a product can be forwarded to the manufacturing plant. This paperless communication between the designer and the manufacturer requires resolving psychological, technical and organizational problems.

These problems are:

1. Defining the status of the design file on the magnetic medium in the interactions of the designer and the manufacturer.

2. Establishing a set of rules for the transfer of the magnetic data files in an integrated form.

3. Defining the procedures for the designer and manufacturer's interactions in the transfer of magnetic data files.

4. Setting the rules for naming new types of documents.

5. Defining and regulating the relationships of integrated magnetic files and conventional design documentation. The necessity and conditions for simultaneous use of the two types of documents must be defined.

6. Specifying the authorized personnel whose approval and signature are required for magnetic data files; specifying the information needed for the use and circulation of magnetic files and identifying where they are kept, i.e., the magnetic counterpart of the conventional "basic inscription."

7. Setting the rules and procedures for storage, cataloguing, and handling of magnetic files in the integrated form of representation.

8. Setting the rules and procedures for file revisions and updating.

Thorough analysis is needed for solving these problems to the point of formulating specific rules and conditions. In this paper we will thus discuss only the general direction of such solutions.

1. The status of a file of design documents on magnetic medium is problematic, because this kind of file cannot be "tied" to the concrete document and because the information it contains can be used for various applications.

This is the crucial problem, as its solution determines the way of addressing all the other problems.

The status of a magnetic recording of a design document can be established according to its basic purposes and contents.

The contents of the file are defined by its name. The file contains data on a product, its design and components; in other words, there are the same data contained in conventional design documents. In this case, however, the data are not duplicated and are all kept in a file in a structure fixed in advance.

The main purpose of the data in the file is to be used in the manufacture of products, i.e., the main purpose is identical to the function of design documents.

The encyclopedia definition of a document states that this concept includes, among other things, a magnetic tape with information recorded for transmission in time and space. It thus follows that the status of an integrated magnetic file of design documents is determined by treating such a file as a "document" in the sphere of design documentation.

The document will acquire the force of law after resolution of all other problems listed above, in conformity with State Standard (GOST) 6.10.4-84, "YeSKD [Unified System of Documents]: Legally Defining Documents on Mechanical Media and Printouts Generated by Computers: Basic Principles."

2. Transmission of magnetic documents requires preparation and formatting of documents to be transmitted, as well as solving problems involved in the transmission process itself.

This poses new questions that do not arise with the transfer of conventional design documents. For example, can one transfer a magnetic document

separately or only as part of a complete set of product documentation? Should one allow the transfer of information in an early stage of product development before the complete set of documents is provided, so as to make it possible to utilize the available data for planning the manufacturing process? How can the integrity of the data on magnetic media be confirmed at the time of their transfer? What kind of shipping documents can be used, and are they needed for transfer? Should there be different procedures for transfer of magnetic documents, depending on whether the document is the original, a duplicate, or a copy?

Once these questions are answered, specific rules for transfer of integrated magnetic documents could be spelled out. These are the crucial questions of document transfer.

3. The problem of magnetic document transfer is connected with the interrelationships between the designer and the manufacturer of the product.

The key aspects of this problem are the following:

--specifying the responsibilities of the designer who transfers the magnetic medium with the data file;

--specifying the rights of the manufacturer who receives the magnetic documents;

--distributing the rights and responsibilities of the designer and the manufacturer, depending on whether what is transmitted is the original, a duplicate, or a copy of the magnetic document.

The possibility of providing the data on a magnetic medium should be agreed upon by the parties and recorded in the technical work order for the development of the product.

We believe that the basic approach is to get the manufacturer involved in computer-aided design of the product. For his part, the designer is responsible for a flawless presentation of the results and their recording on the magnetic medium. Upon mutual agreement, complete or limited monitoring of the manufacturer (by the customer) of the data file on visual displays may be arranged.

4. The labeling of integrated magnetic documents as components of a set of design documents involves the following aspects:

--on the one hand, treating a magnetic data file as a design document, we are legally entitled to assign this document a decimal product code, adding the alphabetical code identifying the document as magnetic.

--on the other hand, the fact that the data on the magnetic medium pertain to several types of design documents, which can all be generated from that medium with identification codes of their own, does not allow addressing this issue in purely formal terms. One cannot draw a direct analogy to the established official standards for designation of design documents on punched

tapes. The rules call for identical labeling of documents on punched cards and tapes and the "conventional" hard copy documents generated from the punched forms.

At first glance the decision should be based on the contents on the magnetic document. In fact, however, the document conttains a data file which is a set of data relevant to several design documents and is used to generate these documents in a visual form. A magnetic document thus corresponds to a set of design documents for a particular product. This calls for using an alphabetic code to identify the document form and the document set. The code should be added to the decimal notation of the product or the assembly.

5. A magnetic file of design data can carry all the information necessary for manufacturing a product. That information is equivalent to a complete set of design documents.

The need for generating design documents in a conventional form depends on the factory, its equipment and the extent to which it is prepared to operate with magnetic documentation in the production process.

At the moment, manufacturers cannot do without conventional design documents for monitoring production, visually ensuring that planned alterations have been included, and putting the data to use in production. This means that, in addition to a magnetic document, some of the documents must be provided in a conventional hard copy form. The connection between the two kinds of documents should be recorded in the specifications of the end products. Such linkage is already done for documents on punched cards or tape, which are entered into the inventory list of computerized information carriers. The list is mentioned in the "Documentation" section of the product specification.

This approach should also be used for magnetic documents: the documents should be entered in a common list together with documents on punched cards or tapes.

6. The main factors in establishing the requirements for the basic inscription of the document in an integrated magnetic form are:

--listing of individuals responsible for information entered and authorized to sign the document;

--determining the rational composition of the basic inscription, considering that detailed information on the data content of a magnetic document is desirable when the data are printed out;

--including information on the relationship between the stored data and the hard-copy design documents.

Solution of the other issues in the structure, composition, and placement of the basic inscription will follow from the above decisions.

The definitions of the original, a duplicate, and a copy can be based on the formulations of GOST 6.10.2-84. The standard identifies magnetic documents as original, duplicate, or copy according to the order in which they were received.

7. The cataloging, storage, and circulation of magnetic documents are regulated separately for originals, duplicates and copies. No essentially novel methods are needed here.

The principles of cataloging, storage, and circulation should be based on the applicable rules and standards of the Unified System of Design Documentation. The differences are only in terms of providing an appropriate environment for physical preservation of the magnetic medium and the availability of "conventional" documents along with the master magnetic document from which they are generated.

8. According to All-Union State Standard 6.10.4-84, any changes in the original magnetic document can be entered only by the organization that originated it.

This requirement did not foresee that the manufacturer would be given the set of software and hardware to afford him a broad range of applications of magnetic documents. Besides, this requirement is at variance with the fundamental requirement of YeSKD standards concerning revisions of design documents, which allow any enterprise holding a document to enter changes either in the originals or in the copies. Only the holders of the originals are allowed to issue notifications of revisions.

Since the magnetic documents discussed here are classified as design documents, it is logical to be guided by YeSKD standards in setting the revision policies. Whether the manufacturer is provided with a copy or an original of a design document file on magnetic media, the manufacturer must be given facilities for changing that file. The manufacturers should be supplied a set of unified software and hardware, enabling them to do all the necessary operations on magnetic files of design documents (such as generating conventional documents, entering modifications or performing other functions).

The designers retain the right and responsibility for issuing notifications of changes if they keep the original.

This policy provides for rapid revisions and response to changes in computerized planning of manufacturing operations and efficient use of computers in the industry.

The notifications of revisions should be formatted and issued in accordance with GOST 2.505-82.

Adopting decisions on all the issues listed above and collating them out in technical normative documents will help factories to introduce new designs

faster and accelerate the introduction of computerized systems into industry, eliminating "paper-based" communications between designers and manufacturers, so that in the future an automatic "design-manufacturing" cycle could be put in place.

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System for Monitoring Automated Scientific and Technical Information Systems

18630087 Moscow NAUCHNO-TEKHNICHESKAYA INFORMATSIYA--SERIYA 1: ORGANIZATSIYA I METODIKA INFORMATSIONNOY RABOTY in Russian No 8, 1987 (manuscript received 19 Dec 86) pp 9-10

[Article by A. L. Gavronskiy, N. I. Gryaznov and V. F. Rudakov]

[Abstract] This article presents a description of a system developed at the All-Union Institute for Scientific and Technical Information for monitoring the functioning of automated scientific and technical information systems. This monitoring system is supported by a data base entitled "Administration of the State Automated Scientific and Technical Information System," which analyzes the functioning of the information system. The results of the analysis are supplied to the State Committee for Science and Technology, which uses them to generate recommendations and develop methodological approaches. The data base is supplied with information through the automated information centers, where statistics on functioning of the scientific and technical information systems are calculated. The software is organized as a set of programs implementing three main processes: Input; output of responses to queries; and dialog with the monitoring system through remote access terminals. Figures 1, references 2: Russian.

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Hardware Protocols: The Transition From Specifications to Implementation

18630103b Riga AVTOMATIKA I VYCHISLITELNAYA TEKHNIKA in Russian No 5, Sep-Oct 87 (manuscript received 27 Feb 87) pp 82-88

[Article by V. I. Varshavskiy, V. B. Marakhovskiy, L. Ya. Rozenblyum, Yu. S. Tatarinov and A. V. Yakovlev]

[Abstract] This article is the continuation of a previous study on the reliable implementation of interfacing protocols for hardware architecture. Interfacing protocols call for asynchronous and parallel interactions among linked computers. Special means of "translation" must be devised to convert these specifications into actual circuitry. The development of a protocol model involves three stages: layout of the basic scenario for interactions (done with the formalism of temporal signal graphs in this article); refinement of the scenario through consideration of the specific communications lines, coding methods, etc., used; and construction of the final model, which involves consideration of the influence of higher-level protocols and a more precise description of the computers involved (registers, drives, etc.). A number of necessary properties of the communicating facilities must be considered in all three stages of this process; this article deals with only one of them: self-synchronization. It describes a means of translation from specifications in the language of signal graphs through transition diagrams and Mahler diagrams, to aperiodic (self-synchronizing) implementation. This aperiodic approach is capable of self-verification and can thus diagnose constant defects; a degenerating system can thus reconstruct itself. Temporal signal graphs, transition diagrams, and Mahler diagrams are described in detail. The alternative solution drawing on the theory of aperiodic automata is given for the case in which the signal graph leads to a contradictory transition diagram. Figures 3, references 7: 4 Russian, 3 Western.

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Software for Debugging Programs for the "Elbrus" Data Transmission Processor

18630103a Riga AVTOMATIKA I VYCHISLITELNAYA TEKHNIKA in Russian No 5, Sep-Oct 87 (manuscript received 10 Apr 86) pp 29-37

[Article by Ye. M. Larin, V. I. Perekatov and M. M. Fomichev]

[Abstract] Programs for the data transmission processor of the Elbrus multiprocessor computer system are written in the problem-oriented language SETRAN, under the operating system INTROS. These programs inevitably require debugging. The basic requirements for such software include debugging of SETRAN programs without reverting to the operating system level and without requiring additional equipment or modification of attendant programs. All components of the debugging system must be invariant, regardless of the type of network terminal used, communications channels, and protocols. Full recording of all types of interrupts in the transmission program's communications with linked computers is required. Recording of command messages sent to the program from the control system and result messages sent from the program to the center is also necessary. The programmer should be able to determine the chain of operators executed by the program in handling each interrupt or message.

The debugging facilities developed to meet these requirements include two complementary systems--IMITATOR and SLED [TRACE]. The former supports debugging of SETRAN programs during independent oepration of the data transmission processor, while the latter collects and displays information on the dynamics of software processing of interrupts and messages. The functions of the two systems are outlined. An example of a debugging dialog and print-out of a fragment of the SLED buffer are presented, as are source and object code fragments of the program being debugged. Figures 3, references 2: Russian.

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Effectiveness of Task Distributing Algorithms in Multiple Computer Systems

18630102 Riga AVTOMATIKA I VYCHISLITELNAYA TEKHNIKA in Russian No 5, Sep-Oct 87 (manuscript received 23 Feb 87) pp 48-54

[Article by V. Ye. Kolesnichenko and G. V. Chechin]

[Abstract] Previous studies of the effectiveness of algorithms for distributing independent tasks among the computers in a unified system have assumed a complete a priori knowledge of input parameters. In real-life situations, though, such information is usually lacking; and this article thus examines the effectiveness of such algorithms when information on the rate of input of tasks and their mean processing time is incomplete. An exponential distribution function for the interval between the moment of arrival of a task and its processing time is assumed, as it makes possible the generation of explicit analytic relationships and yields the maximum estimate of lag time for tasks in the system.

In keeping with tradition, the algorithms examined are classified as dynamic and static, and the latter are subdivided into determinate and probabilistic. Primary attention is paid to dynamic algorithms that examine changes in the load on individual computers. These algorithms are analyzed for effectiveness of transmission of service information concerning current computer loads by both the computers themselves and the central dispatcher. In the case of statis algorithms, requirements for choice of the length of the regenerative interval for service information are worked out. Figures 5, references 13: 9 Russian, 4 Western.

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Scheduling in Parallel Structured Programs for Multiprocessor Computing Systems With Heterogeneous Processors

18630101 Moscow AVTOMATIKA I TELEMEKHANIKA in Russian No 10, Oct 87 (manuscript received 4 Sep 86) pp 166-178

[Article by A. P. Barban and V. M. Orisenko, Moscow]

[Abstract] This article describes and proves the premises of a new criterion for the construction of algorithms for scheduling the tasks of various multiprocessor computer systems having a single type of central processors and groups of single-type peripheral processors. The purpose of the resultant algorithms is reduction of the total time of execution of sets of related parallel tasks when the time of execution of any one of them is determined by an unknown distribution function. In the article, graphs and chains of tasks indicating order of precedence are used to describe the relationship between the computer system and parallel program models. The concrete example examined in the article is the PS-3000 system, with two types of processors--one central and one peripheral. The functioning of an algorithm based on the new criterion is described, and the differences between it and existing ones are pointed out.

Experiments were performed on graphs with up to 70 vertices (of single programs and structures), which were grouped by the paralleling algorithm into parallel-series branches of from five to ten each.

The scheduling results of the new criterion were always at least as efficient as those of the existing criterion. As expected, the differences between the results approached a minimum for commensurate tasks as the number of input-output procedures increased in relation to the number of computations required. Figures 5, references 7: Russian.

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